PROJECT: NORTH OAKVILLE #3
CATHOLIC ELEMENTARY SCHOOL
& CHILDCARE FACILITY

CLIENT: HALTON CATHOLIC DISTRICT SCHOOL BOARD

PROJECT No.: 24106

DATE: NOVEMBER 2026

BINDER: B MECHANICAL & ELECTRICAL



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Division 21 Fire Suppression

Common Contract Requirements for Fire Suppression

21 02 51 Fire Protection General Requirements
21 02 61 Fire Protection Occupancy Requirements

Facility Fire Suppression Water Service Piping

21-05-19 Pressure Gauges

Fire Suppression Sprinkler Systems

21 13 13 Wet Pipe Fire Suppression

Division 22 Plumbing

Contract Requirements for Plumbing

22 02 21 Plumbing Supplemental Tender Form
22 02 51 Plumbing General Requirements
22 02 61 Plumbing Occupancy Requirements

Common Work Results for Plumbing

22 05 11 Plumbing Work Requirements
22 05 19 Thermometers and Pressure Gauges
22 05 31 Plumbing Expansion Joints, Anchors, and Guides
22 05 34 Plumbing Bases, Hangers, and Supports (Indoor)
22 05 48 Plumbing Seismic Restraint
22 05 49 Plumbing Vibration and Noise Control Measures
22 05 53 Identification of Plumbing Services

Commissioning for Plumbing

22 05 65 Plumbing Contractor Commissioning Requirements

Common Work Results for Plumbing

22 06 33 Heat Tracing for Plumbing & Drainage

Plumbing Insulation

22 07 19 Plumbing Piping Insulation

Facility Water Distribution

22 11 11 Site Services - Water Mains
22 11 16 Domestic Water Piping
22 11 20 Backflow and Cross Connection Measures
22 11 31 Potable Water Auxiliary Equipment

Facility Sanitary Sewerage

22 13 11 Site Services - Sanitary Sewers
22 13 13 Sanitary Drains
22 13 16 Sanitary Waste and Vent Piping – Cast Iron and Copper
22 13 17 Sanitary Waste and Vent Piping – Plastic
22 13 23 Sanitary Interceptors

Facility Storm Drainage

22 14 11 Site Services - Storm Sewers
22 14 15 Storm Drainage Piping – Cast Iron and Copper
22 14 16 Storm Drainage Piping - Plastic
22 14 26 Storm Drains

Fuel-Fired Domestic Water Heaters

22 34 36 Fuel-Fired Domestic Water Heaters

Plumbing Auxiliary Equipment

22 36 13 Plumbing Auxiliary Equipment

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 21 HVAC Supplemental Tender Form
23 02 51 HVAC General Requirements
23 02 61 HVAC Occupancy Requirements

Common Work for HVAC

23 05 11 General HVAC Work Requirements
25 05 12 Variable Frequency Drives (VFD)
23 05 19 Thermometers and Pressure Gauges
23 05 31 HVAC Expansion Joints, Anchors, and Guides
23 05 34 Bases, Hangers and Supports (Indoor)
23 05 35 Bases, Hangers, and Supports (Outdoor)
23 05 48 HVAC Seismic Restraint
23 05 49 HVAC Vibration and Noise Control Measures
23 05 53 Identification of HVAC Services

Common Work Results for HVAC

23 06 33 Heat Tracing for HVAC Piping
23 06 81 Pipe Welding

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
23 10 16 HVAC Equipment Insulation
23 10 19 HVAC Piping Insulation

Facility Fuel Piping

23 11 23 Facility Natural-Gas & Propane Piping

Hydronic Piping and Pumps

23 21 11 Hydronic Accessories
23 21 13 Hydronic Piping - Screwed/Welded
23 21 23 Hydronic Pumps

Refrigerant Piping

23 23 13 Refrigerant Piping and Specialties

HVAC Water Treatment

23 25 13 Water Treatment for Closed-Loop Hydronic Systems

HVAC Ducts and Casings

23 31 13 Metal Ducts

Air Plenums and Chases

23 32 13 Fabricated, Metal Air Plenums

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 19 Duct Silencers
23 33 46 Flexible Ducts
23 33 53 Duct Liners

HVAC Fans

23 34 23 Packaged Exhausters
23 34 41 Destratification Fans

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 and Vents for Intake and Exhaust

Breeching, Chimneys, and Stacks

23 51 33 Insulated Sectional Chimneys

Heating Boilers

23 52 13 Stainless Steel Fire Tube Condensing Boilers

Heat Exchangers for HVAC

23 57 19 Liquid to Liquid Heat Exchangers

Packaged Water Chillers

23 64 23 Scroll Water Chillers (Air Cooled)

Air-To-Air Energy Recovery Equipment

23 72 13 Heat-Wheel Air-to-Air Energy-Recovery Ventilators (Enthalpy)

Indoor Central-Station Air-Handling Units

23 73 23 Custom Indoor Central-Station Air Handling Units

Packaged Outdoor HVAC Equipment

23 74 43 Packaged Rooftop HVAC Units

Decentralized Unitary HVAC Equipment

23 81 19 LAN Room Air Conditioners

Convection Heating and Cooling Units

23 82 19 Fan Coil Units (Heating or Cooling)
23 82 29 Radiators, Convectors, and Cabinet Heaters
23 82 31 Hydronic Radiant Ceiling Panels

Division 25 Integrated Automation

Building Automation System

25 20 11 Building Automation System

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 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.

.8 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.

.9 Check work described by catalog data with Contract Documents for deviations and errors.

.10 Shop drawings and product data shall show:

.1 Mounting arrangements.
.2 Operating and maintenance clearances. e.g., access door swing spaces.

.11 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.

.12 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.

.13 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 review and approval. Submission of individual data will not be accepted unless directed by Consultant. Submission can be done electronically in PDF format or as a hard copy.

.1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.

.2 Hard copy 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 and Maintenance Manual.

.3 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 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.

1.19 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.

1.20 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.

1.21 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.

1.22 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.

1.23 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.

1.24 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.

1.25 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.

1.26 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.

1.27 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.

1.28 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.

1.29 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.

1.30 DISCONNECTION AND REMOVAL

.1 Disconnect and/or remove equipment, piping, etc. as indicated.

.2 Cap and conceal all redundant and obsolete connections.

1.31 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.

1.32 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.

1.33 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

1.34 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 from all standpipe systems at the most remote and highest hose connection.

.5 Test flow thru all backflow preventors.

.6 Test flow thru all fire pumps.

.7 Other test that maybe a requirement of NFPA.

.3 All test 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 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 NFPA-13 Contractors Material and Test Certificate (sprinkler)
  - .2 NFPA-13 Fire Protection Bypass Flow Test
  - .3 Sprinkler Design Engineers' Letter
  - .4 Letter confirming system has been tested with the Integrated Testing Contractor.
  - .5 Engineer's seismic restraint letter.

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 ANSI/ASME B40.100, Pressure Gauges and Gauge Attachments.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Submit manufacturer's product data for following items:

.1 Pressure gauges

.2 Stop cocks

.3 Siphons.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid point of scale or range.

.2 Ranges: suitable for application.

2.2 PRESSURE GAUGES

.1 115 mm (4 1/2"), dial type: to ANSI/ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.1 Acceptable Manufacturers:

.1 Winters

.2 Trerice

.3 Wiess.

.2 Provide:

.1 Snubber for pulsating operation.

.2 Gasketed pressure relief back with solid front.

.3 Bronze stop cock.

Part 3 Execution

3.1 GENERAL

.1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Upstream and downstream of backflow preventors.

.4 In other locations as indicated.

.2 Install gauge cocks for balancing purposes, elsewhere as indicated.

3.3 NAMEPLATES

.1 Install engraved lamicoid nameplates as specified elsewhere identifying medium.

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 Polished chrome plated recessed with identifying sign cast on plate. Threaded metal caps and chains.

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 Complete with lock and chain where indicated.

.12 Complete with supervisory valves where indicated.

.13 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

.14 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 through 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 through the bypass to prove system demand can be provided through the backflow preventer.

END OF SECTION

Part 1 General

1.1 INSTRUCTIONS TO BIDDERS

.1 The Supplemental Tender Form must be submitted to the architect and consultant (admin@deiassociates.ca) within 2 hours after tender closing. Contractors shall identify all sub-contractors he/she intends to use and must complete all information requested. The requisite information shall be given at the office of the Consultant. Contractor shall sign and date this page and initial and date each page thereafter.

.2 Should the Plumbing Supplemental Form not be submitted then the contractor shall use Base Bid manufacturers as listed.

.3 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

.4 SUB-CONTRACTORS

The Contractor shall state below the name of the Sub-contractors he intends to use, which shall not be changed without the consent of the Consultant.

Site Services _____

Insulation _____

.5 The Stipulated Bid Sum shall be for the base bid manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer he intends to use. Where no choice is indicated, the base bid supplier or equipment shall be used.

.6 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified, provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Plumbing Contractor shall not indicate equipment, materials or suppliers which are not listed. If this is done, the base bid supplier shall be used.

.7 Where modifications to the work of other trades are required as a result or part of the alternative offered, include the cost of said modifications in the work.

.8 Submit the following list of Base Bid and alternative suppliers in accordance with the bid requirements:

Spec. Reference Section	**Equipment**	**Base Bid**	**Acceptable Alternate Manufacturer Or Supplier**	**Indicate Manufacturer Or Supplier**
22 05 19	Direct Reading Thermometers	Trerice	Winters 91T Wiess	
22 05 19	Remote Reading Thermometers	Trerice	Winters 91T	
22 05 19	Pressure Gauges	Winters 91T	Trerice Weiss	
22 05 31	Expansion Compensators (EXP) (2"-4")	Metraflex HP	Mark David Canada Senior Flexonics	
22 05 31	Expansion Compensators (EXP) (6"-16")	Metraflex Metragator	Mark David Canada Senior Flexonics	
22 05 34	Plumbing Bases, Hangers, and Supports (Indoor)	Grinnell	Anvil Myatt Taylor	
22 05 48	Plumbing Seismic Restraint	Kinetics Noise Control Inc.	Copper 'B' Line Unistrut Building Systems Mason Industries	
22 07 19	Thermal Insulation for Plumbing Piping	Johns Manville	Knauf Manson Owens Corning	

CONTRACTOR'S NAME:_____ DATE:_____

Spec. Reference Section	**Equipment**	**Base Bid**	**Acceptable Alternate Manufacturer Or Supplier**	**Indicate Manufacturer Or Supplier**
22 11 16 Copper	Circuit Setter Domestic Water Recirculating Valve	ThermOmega Tech Inc.	CircuitSolver®	
22 11 16 Stainless Steel	Circuit Setter Domestic Water Recirculating Valve	ThermOmegaTech Inc.	CircuitSolver®	
22 11 16 Domestic Water Piping	Valves	Milwaukee	Crane Neuman Hattersley Kitz	
22 11 16 Domestic Water Piping	Butterfly Valves	Victaulic Series 608		
22 11 20	Backflow Devices	Watts	Wilkins	
22 11 31	Non Freeze Wall Hydrants (Recessed, Encased)	Zurn Z-1300	Mifab MHY-20 Ancon HY-725 Contour C7100	
22 11 31	Back Flow Preventors Double Check Valve Assembly (DCVA)	Watts 007 ½" - 2"	Wilkins 950XL ¾" - 2" Conbraco 40-100 Series	
22 11 31	Water Make-Up Assembly	Watts	Conbraco	
22 13 13	Drainage Supplies	Zurn	Ancon Smith Mifab Watts Contour Enpoco Jay R. Smith Polydrain	

CONTRACTOR'S NAME:_____ DATE:_____

Spec. Reference Section	**Equipment**	**Base Bid**	**Acceptable Alternate Manufacturer Or Supplier**	**Indicate Manufacturer Or Supplier**
22 14 26	Storm Drains	Zurn	Mifab Watts Jay R. Smith Ancon Contour Smith	
22 44 13	Fixture Carriers	Zurn	Smith Ancon	
22 44 13	Plumbing Fixtures	Delta	McGuire	
22 06 33	Heat Tracing for Plumbing and Drainage	Chromalox	Raychem 3M Serge Baril Heron Cable Ind. Easy Heat (Emerson)	
22 11 22	Domestic Water Circulation Pump	Bell & Gossett	Armstrong Taco	
22 11 31	Water Meters	Neptune		
22 13 13	Trap Seal Stations	Mifab	Watts Zurn	
22 13 13	Solenoid Valves (Header Trap Seal Primer)	Asco		
22 13 23	Enzymatic Grease Interceptors (Steel)	Zurn	Mifab Jay R Smith Ancon	
22 33 33	Electric Domestic Water Heater	A.O. Smith	Ruud Bradford White J. Wood Rheem Ruud	
22 36 13	Domestic Hot Water Expansion Tank	Amtrol ST-12C	Well-X-Trol	

CONTRACTOR'S NAME:_____ DATE:_____

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
22 37 13	Fire Extinguishers	Wilson & Cousins	National	
22 37 13	Fire Blanket	National	Wilson & Cousins	
22 34 36	Fuel Fired Domestic Water Heaters	A.O. Smith	Ruud Bradford White J. Wood Clemmer McDonnell Miller	
22 36 13	Domestic Hot Water Circulating Pumps	Bell & Gosset	Armstrong Taco	
22 36 13	Thermostatic Water Controller (3 Port)	Symmons	Powers	

1.2 LABOUR RATES

.1 The following labour rates shall apply for calculating the cost of credit or extras on Change Notices. The rates shall include any employee benefits. The labour rates do not include overhead and profit.

Superintendent $_____/hr

Journeymen $_____/hr

Labourers $_____/hr

Plumbers $_____/hr

Insulation $_____/hr

Other $_____/hr

1.3 PLUMBING TENDER PRICE (EXCLUDING HST)

.1 Having carefully examined all Drawings and Specifications and the Addenda to the Drawings and Specifications, and having carefully examined the sites and all conditions affecting the work, we, the undersigned thereby offer to provide all plant, labour, materials and incidentals required to complete the work of all trades for: All the work specified for herein for

the Total Stipulated Price of: $_____

_____

(in writing)

in lawful money of Canada; included in which are all applicable excise taxes, custom duties, freight, exchange, and all other charges. HST is not included.

Part 2 Products

2.1 NOT USED

Part 3 Products

3.1 NOT USED

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 TENDERS AND BONDING

.1 Complete Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of tender documents.

.2 Submit Supplemental Tender Form as noted.

.3 Submit tender based on specified described equipment or Alternates listed.

.4 State in Tender, names of all Subcontractors proposed for work under this Division.

.5 No bonding required for this contractor.

1.4 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.

1.5 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 fittments.

.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.

1.6 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.

1.7 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.

1.8 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.

1.9 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.

1.10 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 affect 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.

1.11 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

1.12 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. $2,000.00)
.2 Inside buried plumbing and drainage
.3 Above grade rough-in plumbing and drainage
.4 Roof drainage system
.5 Plumbing fixtures
.6 Plumbing equipment

.7 Specialty piping

.8 Piping insulation

.9 Firestopping

.10 Plumbing contractor closeout requirements (min. of 3% for the first $500,000.00, 1% from $500,000.00 to $5,000.000.00, and 0.5% beyond. Shall not be less than $5,000.00).

.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.

1.13 COMMISSIONING CONTRACT BREAKDOWN

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

1.14 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 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.

.8 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.

.9 Check work described by catalog data with Contract Documents for deviations and errors.

.10 Shop drawings and product data shall show:

.1 Mounting arrangements.

.2 Operating and maintenance clearances. e.g., access door swing spaces.

.11 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.

.12 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.

.13 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.

1.15 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.

1.16 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 directed by Consultant. Submission can be done electronically in PDF format or as a hard copy.

.1 Electronic submission/PDF file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.

.2 Hard copy 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 and 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.

1.17 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 submittal for TAB and review:

.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" (Company Name) (Signature of Contractor) (date).

.3 TAB to be performed using as-built drawings.

.4 Submit copy to Consultant for review and approval. When returned, make corrections as directed.

.3 As-built drawings final submittal:

.1 Once approved, submit completed, reproducible paper as-built drawings as well as a scanned PDF file copy on USB stick with Operation and Maintenance Manuals. Once approved, submit completed, reproducible paper as-built drawings as well as a scan PDF of **each** drawing file on USB stick (note PDFs cannot be combined).

1.18 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.

.3 If plumbing sub-contractor with offices located more than 80 km (50 miles) from Project site is used, provide service/warranty work agreement for warranty period with local plumbing sub-contractor approved by Consultant. Include copy of service/warranty agreement in warranty section of Operation & Maintenance Manual.

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.

.4 Warranty Duration:

.1 One (1) year warranty period applies unless otherwise noted.

.5 Warranty Coverage:

.1 Applies to parts and labour.

1.19 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

1.20 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.

1.21 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.

1.22 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)

.3 Seismic Restraint Engineers' Letter

Part 2 Products

2.1 Not Used

Part 3 Execution

3.1 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	Hose bibbs	+/- 600 (24")
.7	Shower heads (Standard)	2.0 m (6' – 6") to bottom of head
		Shower heads (Barrier-free)
		adjustable from 1200 (48") to 2030 (80")
.8	Barrier-free shower seat	+/- 470 (18.5")
.9	Barrier-free drinking fountains	840 mm (33") to rim Not less than 686 (27") under unit
.10	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 VIDEO RECORDING OF NEW 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 Provide an additional video of the sanitary & storm underground prior to turn-over of school to the board.

.3 This contractor shall flush the new and existing storm and sanitary system to remove all debris prior to final video taping of systems.

.4 Provide 1 copy of USB.

.5 Identify video routing on As-built drawings.

1.28 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.

1.29 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.

1.30 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.

1.31 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 ciruit setter balancing valve.

.4 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

1.32 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.

1.33 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.

1.34 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.

1.35 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.

1.36 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.

1.37 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.

1.38 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 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ANSI/ASME B40.100, Pressure Gauges and Gauge Attachments.

.3 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

.4 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Submit manufacturer's product data for following items:

.1 Thermometers.

.2 Pressure gauges.

.3 Stop cocks.

.4 Siphons.

.5 Wells.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid point of scale or range.

.2 Ranges: suitable for application.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, liquid filled, 225 mm (9") scale length: to CAN/CGSB 14.4.

.1 Acceptable Manufacturers:

.1 Trerice

.2 Winters

.3 Wiess

2.3 REMOTE READING THERMOMETERS

.1 100 mm (4") diameter liquid filled activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless steel case for wall mounting.

.1 Acceptable Manufacturers:

.1 Trerice

.2 Winters

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

.1 115 mm (4 1/2"), dial type: to ANSI/ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.1 Acceptable Manufacturers:

.1 Winters

.2 Trerice

.3 Wiess

.2 Provide:

.1 Siphon for steam service.

.2 Snubber for pulsating operation.

.3 Diaphragm assembly for corrosive service.

.4 Gasketted pressure relief back with solid front.

.5 Bronze stop cock.

Part 3 Execution

3.1 GENERAL

.1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

.1 Install in wells on all piping. Provide heat conductive material inside well.

.2 Install in locations as indicated and on inlet and outlet of:

.1 Water heaters/DHW boilers inlet and outlet.

.2 All ports of thermostatic mixing valve.

.3 In other locations indicated.

.3 Install wells as indicated only for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Upstream and downstream of control valves.

.4 Inlet and outlet of coils.

.5 Inlet and outlet of liquid side of heat exchangers.

.6 Outlet of boilers.

.7 Inlet and outlet of backflow preventors.

.8 Upstream & downstream of water meters.

.9 In other locations as indicated.

.2 Install gauge cocks for balancing purposes, elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

.1 Install engraved lamicoid nameplates as specified elsewhere identifying medium.

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 BELLOWS TYPE EXPANSION JOINTS

.1 For axial, lateral or angular movements, as indicated.

.2 Maximum operating pressure: 1034 kPa (150 psi).

.3 Maximum operating temperature: 200°C (392°F).

.4 Type A: Free flexing, factory tested to 1½ times maximum working pressure. Furnish test certificates.

.5 Type B: Externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1.5 times maximum working pressure. Furnish test certificates.

.6 Bellows:

.1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

.7 Reinforcing or control rings:

.1 2 piece nickel iron.

.8 Ends:

.1 Slip-on flanges to match pipe.

.9 Liner:

.1 Austenitic stainless steel in direction of flow.

.10 Shroud:

.1 Carbon steel, painted.

2.6 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.

2.7 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.

2.8 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

2.9 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

2.10 FLOATING RISER SYSTEM COMPONENTS

.1 Free Standing Spring Isolator

.1 Vibration isolators shall be free standing, unhoused, laterally stabile steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed to provide a minimum 50% overload capacity.

.2 Springs shall be assembled or welded between top and bottom load plates. The upper load plate shall be provided with steel leveling bolts, lock nut and washer for attachment to the supported equipment. The lower load plate shall incorporate a non-skid noise isolation pad and shall have provisions for bolting the isolator to the supporting structure, as required.

.3 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as otherwise indicated on the project documents. Springs shall be colour coded or otherwise identified to indicate load capacity.

.4 Design Basis: Kinetics Noise Control, Model FDS.

.2 Coil Spring Isolator Incorporated with a Steel Housing

.1 Spring isolators shall be seismic control restrained spring isolators, incorporating a single vibration isolator, having all the characteristics of the free-standing open spring isolators as previously specified. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation of the spring during normal equipment operating conditions.

.2 Vibration isolators shall incorporate a steel housing and snubbing grommet system designed to limit motion to approximately 0.2" (5 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed housing. The restraining system shall be designed to withstand a force equivalent to 1.0 g in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, an adapter plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation spring, the load path will include a minimum 0.25" (6 mm) thick neoprene pad.

.3 To facilitate servicing, the isolator will be designed in such a way that it can be removed without the requirement to lift or otherwise disturb the supported equipment.

.4 Design Basis: Kinetics FHS and FHSL.

.3 Seismic Control Restrained Spring Isolator

.1 Vibration isolators shall be seismically rated, restrained spring isolators for equipment which is subject to load variations and large external forces. Isolators shall consist of large diameter, laterally stable, steel springs assembled into welded steel housing assemblies designed to limit movement of the supported equipment in all directions.

.2 Housing assembly shall be of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom plate with internal non-skid noise isolation pads and holes for anchoring of housing to supporting structure. Housing shall be hot dip galvanized for corrosion resistance. Housing shall be designed to provide a constant free and operating height within 1/8" (3 mm).

.3 The isolator housing shall provide a minimum of 1 g restraint in all directions.

.4 Spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Springs shall be colour coded or otherwise identified.

.5 Spring elements shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be polyester powder coated and shall have a 1000 hr rating when tested in accordance with ASTM B-117.

.6 Design Basis: Kinetics FLSS.

.4 All Direction 3 Axis Riser Anchor Assembly

.1 Risers shall be restrained against excessive movement during service by the use of 3-axis resilient anchors designed to withstand the required installation and operating forces. Anchors are intended to be used in sets of two (2) and be oriented to effectively restrain the riser in all three directions, with particular emphasis on large and variable vertical loads that would be imparted by changes in the riser weight.

.2 Anchors shall be of steel construction and shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical riser movement at each anchor location to a maximum of ¼" (6 mm) in any direction.

.3 Anchors shall include a minimum 1/2" (13 mm) thick resilient neoprene pad to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Anchors shall be capable of withstanding an externally applied force of up to their rated capacity in any direction.

.4 Design Basis: Kinetics KPA.

.5 Horizontal Motion Limiting Riser Guide Assembly

.1 Risers shall be restrained against excessive lateral movement during service by the use of 2-axis resilient guides designed to withstand the required installation and operating forces. Guides are intended to be used in sets of two (2) and be oriented to effectively restrain the riser in all horizontal directions, but to allow free motion within their operating range in the vertical axis.

.2 Guides shall be of steel construction and shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design loads. Guides shall limit lateral riser movement at each Guide location to a maximum of ¼" (6 mm) in any direction.

.3 Anchors shall include a minimum 1/2" (13 mm) thick resilient neoprene pad to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Anchors shall be capable of withstanding an externally applied lateral force of up to their rated capacity in any direction.

.4 Design Basis: Kinetics KRG.

.6 Spring Isolation Hanger

.1 Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding 0.4" (10 mm), shall be hangers consisting of a free-standing, laterally stabile steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket.

.2 The bracket shall be finished with a polyester powder coating.

.3 The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.

.4 The 1" and 2" hanger brackets shall incorporate spring caps with indexed steps which correspond to the washer diameter of appropriately sized hanger rod to keep the rod centered in the spring cap and reduce rod misalignment.

.5 Springs shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.

.6 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as indicated on the project documents. Springs shall be colour coded or otherwise identified to indicate load capacity.

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 contract 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 <u>not</u> 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 RISER CLAMPS

.1 Steel or cast iron pipe: black carbon steel to MSS-SP-58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS-SP-58, type 42.

.3 Bolts: to ASTM A 307.

.4 Nuts: to ASTM A 563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m² (13.12 lbs/ft²) 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.

2.5 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.

2.6 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 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 APPLICATION

.1 Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.

.2 Where the structural engineer or architect documents have Ie*Sa(0.2)*Fa<3.5 seismic is not required on the plumbing, mechanical, electrical, or fire protection systems.

.3 Where the structural engineer or architect documents have Ie*Sa(0.2)*Fa≥3.5 seismic is required on the plumbing, mechanical, electrical, or fire protection systems.

.4 Seismic will always be required on fire protection systems when required by NFPA codes.

.5 Seismic will always be required on any “Disaster Relief Building.” For example, hospitals, police stations, ambulance building, etc.

.6 When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

1.2 SECTION INCLUDES

.1 Seismic Requirements for single rod hanger support for conduit, pipe and other similar systems.

.2 Seismic Requirements for trapeze type supports for cable tray, conduit, pipe and other similar systems.

.3 Seismic requirements for all plumbing equipment and piping.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Vibration Isolation Measures.

1.4 REFERENCE STANDARDS

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 National Building Code of Canada (NBC).

.3 Canadian Standards Association

.1 CSA S832, Seismic Risk Reduction of Operation and Functional Components (OFCs) of Buildings.

.2 CAN/CSA-S16.1 Limit States Design of Steel Structures

.3 CAN3-S136 Design of Cold Steel Structural Members

.4 CSA W47.1 Certification of Companies for Fusion Welding of Steel

.5 CSA W59 Welded Steel Construction

.4 American Society of Testing and Materials

.1 ASTM A653/S653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (galvannealed) by the Hot Dip Process.

.2 ASTM A879M Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.

.3 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.4 ASTM A325M Specification for Structural Bolts, Heat Treated 830MPa Minimum Tensile Strength.

.5 All local codes.

.6 FEMA: Seismic Restraint Installation Manuals 412. 413. & 414

.1 FEMA 412: Installing Seismic Restraints for Plumbing/Mechanical Equipment

.2 FEMA 413: Installing Seismic Restraints for Electrical Equipment

.3 FEMA 414: Installing Seismic Restraints for Duct and Pipe

.7 ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.).

.8 ASHRAE Applications Handbook; Seismic and Wind Restraint Design Chapter.

1.5 DEFINITIONS

.1 A_v: Effective peak velocity related acceleration coefficient BOCA, SBC Code.

.2 S_1: Mapped Long Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.

.3 S_s: Mapped Short Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.

.4 v: Zonal Velocity Coefficient NBC-Canada.

.5 VISCMA: The Vibration Isolation and Seismic Control Manufacturers Association has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.

.6 VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.

.7 Z: Seismic Zone defines Seismic Coefficient C_a used by UBC Code.

1.6 PERFORMANCE REQUIREMENTS

.1 Design Ground Acceleration Coefficient (A_v, S_s, v, or Z depending on Code = X.XX).

.2 (If IBC or TI-809-04) Design Long Period Ground Acceleration Coefficient (S_1 = X.XX).

.3 Design Soil Type = (S_a, S_b, S_c, S_d) as appropriate. (If NBC Canada, the Foundation Factor).

.4 Importance or Performance Factor appropriate to structure = I_p = X.XX.

.5 If UBC Zone 4, Proximity to Fault and, if less than 10km, Fault Type.

.6 Schedule or drawings indicating critical (Ip = 1.5) Duct/Piping systems, including systems whose importance factor may be increased by proximity to critical components.

1.7 DESCRIPTION OF SYSTEM

.1 It shall be understood that the requirements of this seismic restraint section are in addition to other requirements as specified elsewhere for the support and attachment of equipment and plumbing services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section.

.2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.

.3 All seismic snubber restraint assemblies shall meet the following minimum requirements:

.1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).

.2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.

.3 All snubbers are to include a maximum air gap of 0.25 in (6 mm).

.4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.

.5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:

.1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.

.2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.

.3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

1.8 SYSTEM DESIGN

.1 Seismic restraint manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

.2 The contractor shall furnish, to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length, and width dimensions, and installed operating weights of the equipment to be restrained.

.3 All piping, ductwork and equipment is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as “worst case” reaction loads for each restraint and/or anchor size.

.4 The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size or the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

1.9 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS

.1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.

.2 Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

.3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.

.4 All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 3.01.

.5 Friction from gravity loads shall not be considered resistance to seismic forces.

.6 Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14. Sway bracing used for seismic restraint purposes must be fitted with provisions to resist the vertical force component of the diagonal brace. Single diagonal brace for seismic restraint will not be approved.

1.10 QUALITY ASSURANCE

.1 The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.

.2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.

.3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

.4 Only companies experienced in performing the work of this section shall do the installation.

.5 All seismic restraint installations shall be independently reviewed by the Owners Representative for compliance with project specifications.

1.11 SUBMITTALS

.1 Product Data: Include Seismic Rating Curve for each seismically rated isolator or restraint component.

.2 Samples: The contractor shall submit samples of specified seismic snubber devices for approval.

.3 Shop Drawings shall include the following:

.1 Design Calculations: Calculate requirements for selecting seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years of experience in the design of seismic restraints. Professional engineer shall have local jurisdiction and provide periodic field review and final certification upon completion of the project. All costs and fees associated with the engineering shall be the responsibility of this contractor.

.2 Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.

.3 Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.

.4 Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in “Performance Requirements” Article above. Include the following:

.1 Basis for Certification: Indicate whether the “withstand” certification is based on actual test assembled components or on calculations.

.2 Indicate the equipment is certified to be durable enough to:

.1 structurally resist the design forces and/or

.2 will remain functional after the seismic event.

.5 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

.6 Detailed description of the assumed equipment anchorage devices on which the certification is based.

1.12 DELIVERY, STORAGE, AND HANDLING

.1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.

.2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

1.13 WORK FURNISHED BUT NOT INSTALLED

.1 The materials and systems specified in this section shall be purchased by the plumbing contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

.2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the seismic restraint systems.

1.14 COORDINATION

.1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.

.2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. roof curbs, cooling towers, and other similar equipment).

1.15 INSTALLATION

.1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

Part 2 Products

2.1 MATERIALS

.1 Unless otherwise specified materials used in the Work shall conform to the following:

.1 All steel rolled sections and steel plates shall conform to CAN/CSA G40.21M-300W

.2 All steel hollow structural steel sections shall conform to CAN/CSA G40.21-350W Class C

.3 Structural steel bolts, nuts and washers shall conform to ASTM A325M

.4 Weld electrodes shall be SMAW-E-E480XX and SAW-F480-EXXX.

2.2 ACCEPTABLE MANUFACTURERS

.1 All seismic snubbers and combination restraint/vibration isolation materials specified herein shall be provided by a single manufacturer to assure sole source responsibility for the proper performance of the materials used. Manufacturer is to be a member of VISCMA.

.2 Anchor types and sizes are to be per the design data as provided by the seismic restraint manufacturer.

.3 Materials and systems specified herein and detailed or scheduled on the drawings are based upon materials manufactured by Kinetics Noise Control Inc. Materials and systems provided by other manufacturers are acceptable, provided that they meet all requirements as listed in this specification.

.4 Kinetics Noise Control Inc.

.5 Cooper 'B' Line.

.6 Unistrut Building Systems.

.7 Mason Industries.

2.3 SEISMIC SNUBBER TYPES

GENERAL

(Isolator/Snubber Types contained herein are per ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, HVAC Applications, Seismic and Wind Restraint Design)

.1 Type A, Coil Spring Isolator Incorporated Within a Ductile Iron or Cast Aluminum Housing.

.1 Cast iron or aluminum housings are brittle when subjected to shock loading and are therefore not approved for seismic restraint applications.

.2 Type B, Coil Spring Isolator Incorporated Within A Steel Housing

.1 Spring isolators shall be seismic control restrained spring isolators, incorporating a single or multiple coil spring element, having all of the characteristics of free standing coil spring isolators as specified in the vibration isolation portion of this specification. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.

.2 Vibration isolators shall incorporate a steel housing and neoprene snubbing grommet system designed to limit motion to no more than ¼" (6 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing. The restraining system shall be designed to withstand the seismic design forces in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, a steel adapter base plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation coil spring, the load path will include a minimum ¼" (6 mm) thick neoprene pad.

.3 Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.

.4 . To facilitate servicing, the isolator will be designed in such a way that the coil spring element can be removed without the requirements to lift or otherwise disturb the supported equipment.

.5 Spring isolators shall be Model FHS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (2).

.3 Type C, Coil Spring Isolator Incorporated Within a Steel Housing

.1 Spring isolators shall be seismic control restrained spring isolators, incorporating one or more coil spring elements, having all the characteristics of free standing coil spring isolators per the vibration isolation section of this specification, for equipment which is subject to load variations and/or large external forces. Isolators shall consist of one or more laterally stable steel coil springs assembled into fabricated welded steel housings designed to limit movement of the supported equipment in all directions.

.2 Housing assembly shall be made of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom load plate with internal non-skid isolation pads and holes for anchoring the housing to the supporting structure. Housing shall be hot dipped galvanized for outdoor corrosion resistance. Housing shall be designed to provide a constant free and operating height within ⅛" (3 mm).

.3 The isolator housing shall be designed to withstand the project design seismic forces in all directions.

.4 Coil spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.

.5 Spring isolators shall be Model FLS and FLSS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (3).

.4 Type D, Coil Spring Isolator Incorporated with Integral Seismic Restraint

.1 Spring isolators shall be single or multiple coil spring elements which have all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of this specification, incorporating lateral and vertically restrained seismic housing assemblies. Spring elements shall be readily replaceable without the need to list or remove the supported equipment.

.2 Restraint housing shall be sized to meet or exceed the force requirements of the application and shall have the capability of accepting coil springs of various sizes, capabilities, and deflections as required to meet the required isolation criteria. All spring forces shall be contained within the coil/housing assembly, and the restraint anchoring hardware shall not be exposed to spring generated forces under conditions of no seismic force. Spring element leveling adjustment shall be accessible from above and suitable for use with a conventional pneumatic or electric impact wrench.

.3 Restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. Elastomeric elements shall be replaceable. Restraint shall allow ¼" (6 mm) free motion in any direction from the neutral position. Restraint shall have an overturning factor (ratio of effective lateral snubber height to short axis anchor spacing) of 0.33 or less to ensure optimum anchorage capacity.

.4 Spring isolators shall be Model FMS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (4).

.5 Type E, All Direction Neoprene Isolator

.1 Vibration Isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated cast-in-place top steel load transfer plate for bolting to equipment and a steel base plate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading.

.2 Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact.

.3 Isolator shall have minimum operating static deflections as shown on the project Vibration Isolation Schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.

.4 Neoprene isolators shall be Model RQ as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections .2.01, 2.02 and 2.03 (5).

.6 Type F, Light Capacity All Direction 3-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.

.2 Snubbers shall be of interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.

.3 Snubbers shall include a minimum ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Snubber shall be capable of

withstanding an externally applied seismic force of up to 3,000 pounds (1360 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

.4 Three-axis seismic snubbers shall be Model HS-5 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and 2.01, 2.02, and 2.03 (6).

.2 Type G, Lateral 2-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive lateral movement during a seismic event by the use of 2-axis horizontal resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all horizontal directions, and additional snubbers shall be used as required by seismic design conditions.

.2 Snubbers shall be interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location to a maximum of ¼" (6 mm).

.3 Snubbers shall include a minimum of ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

.4 Two-axis lateral seismic snubbers shall be Model HS-2 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (7).

.3 Type H, Heavy Capacity All Direction 3-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive vertical and horizontal movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.

.2 Snubbers shall be of welded interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.

.3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be capable of withstanding an externally applied seismic force up to 10,000 pounds (4,540 kg) in any direction. Snubber shall be installed

only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

.4 Three-axis seismic snubbers shall be Model HS-7 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (8).

.4 Type I, Horizontal 1-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive horizontal one-axis movement during a seismic event by the use of single-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.

.2 Snubbers shall be of steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location in the direction of impact to a maximum of ¼" (6 mm).

.3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to eliminate any contact during normal equipment operation.

.4 Single-axis seismic snubbers shall be Model HS-1 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (9).

.5 Type J, Cable Restraints for Suspended Piping and Ductwork

.1 Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for piping, ductwork, and suspended equipment in all lateral directions.

.2 Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.

.3 Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is lesser.

.4 Seismic wire rope connections shall be made using overlap wire rope “U” clips or seismically rated tool-less wedge insert lock connectors.

.5 Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical “up” forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable straps. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.

.6 Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.

.7 Seismic cable shall be as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.03 through 1.07 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.8 Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU, or KSCC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.9 Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.10 Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.11 Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.12 Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

2.4 SEISMIC BRACING COMPONENTS

.1 Steel strut shall be 1-5/8 wide in varying heights and mig-welded combinations as required to meet load capacities and designs. A material heat code, part number, and manufacturer's name shall be stamped on all strut and fittings to maintain traceability to material test reports.

.2 Material for epoxy painted strut: ASTM A1011, SS, Grade 33.

.3 Material for pre-galvanized strut: ASTM A653, SS, Grade 33.

.4 Material for hot-dip galvanized strut: ASTM A1011, SS, Grade 33 and hot-dip galvanized after fabrication in accordance with ASTM A123.

.5 Material for fittings and accessories: ASTM A907, Grade 33, Structural Quality or ASTM A1011, SS, Grade 33.

.6 Fittings and accessories: Products shall be of the same manufacturer as strut and designed for use with that product.

2.5 UNIFORM BUILDING CODE REQUIREMENTS

.1 Seismic Zone Factor to Table 16-I for area of jurisdiction.

.2 Soil Profile Type to Table 16-J for area of jurisdiction.

.3 Seismic Importance Factor to Table 16-K for area of jurisdiction.

.4 Component Amplification Factor to Table 16-O for area of jurisdiction.

.5 Component Response Mod. Factor to Table 16-O for area of jurisdiction.

.6 Seismic Coefficient to Table 16-Q for area of jurisdiction.

.7 The total height of the structure (h_r) and the height of the system to be restrained within the structure (h_x) shall be determined in co-ordination with architectural plans and the General Contractor.

.8 Forces shall be calculated for individual supports using the above information. Exceptions to Table 16-O may be utilized. However, all use of exceptions shall be noted on submitted seismic bracing plan documents.

Part 3 Execution

3.1 GENERAL INSTALLATION

.1 Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.

.2 Refer to FEMA Manuals 412, 413, and 414 for typical industry standard installation guidelines.

.3 Upon completion of installation of all seismic restraint materials and before start-up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers/restraints.

.4 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.

.5 All seismic restraint systems shall be installed in strict accordance with the manufacturer's seismic restraint guidelines manual and all certified submittal data.

.6 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

.7 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

.8 Seismic restraints shall be attached to the structural system. Looping restraints around the system is not acceptable.

.9 Do not brace a system to two independent structures such as ceiling and wall.

.10 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

.11 Seismic restraint cables shall be adjusted such that they are not visibly slack, or the flexibility is approximately 25mm under thumb pressure for a 1500mm cable length (equivalent ratio for other cable lengths).

.12 All seismic restraint cables shall be at least 25mm clear of all other equipment and services.

3.2 EQUIPMENT INSTALLATION

.1 All external utility connections to restrained equipment shall be designed to allow differential seismic motion without damage to the equipment or utility connections.

.2 Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

.3 After equipment installation is completed, adjust limit stops following manufacturer's written instructions so that they are out of contact during normal operation.

.4 Adjust snubbers according to manufacturer's written instructions.

.5 Installation of seismic restraints shall not cause any change in position of equipment, resulting in stresses or misalignment.

.6 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration isolation system specified.

.7 Do not install any seismic restraint for equipment, cable trays or conduit that compromises isolation specified.

3.3 PIPING INSTALLATION

.1 Hold down clamps must be used to attach pipe to all trapeze members before applying restraints.

.2 Branch lines may not be used to restrain main lines.

.3 Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.

.4 Attach piping to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.

3.4 FASTENING TO STRUCTURE

.1 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

.2 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

.3 Coring is not permitted for the installation of concrete anchors. Use ground penetrating radar or equivalent method of embedment item detection to locate all embed items including reinforcing steel and electrical conduits. Concrete reinforcing steel and electrical conduits shall not be cut or damaged under any circumstances.

.4 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.

.5 If mounting hole diameter exceeds bolt diameter by more than 0.125" (3 mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.

.6 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.

3.5 INSPECTION

.1 The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.

.2 Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.

.3 The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

.1 Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

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 ELASTOMERIC PADS

.1 Type EP4 - rubber-steel-rubber; 10 mm (3/8") minimum thick rubber bonded to 1.5 mm (16 gauge) steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa (60.2 psi).

.2 Acceptable Manufacturers:

.1 Korfund

.2 IAC Acoustics

.3 Vibro-Acoustics

.4 Vibron

2.3 SPRINGS

.1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.

.3 Cadmium plate for all installations.

.4 Colour code springs.

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

Part 3 Execution

3.1 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.2 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.

.3 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").

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to 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 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 Equipment in Mechanical Rooms: Use size #9.

.2 Equipment above ceiling: use size #1 riveted to ceiling suspension system.

2.3 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
Continuous blow-off		CONT. BLOW-OFF
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

2.4 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.

2.5 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:

System	Minimum Training Times
Pumps	2 hours
Water Heaters	2 hours
Emergency Showers & Eye Wash	2 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 RELATED DOCUMENTS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

.1 Heating cable must conform to CSA 22.2 No.130-03 (latest edition).

1.3 SUMMARY

.1 Section includes heat tracing for fire-suppression piping with self-regulating, parallel resistance.

1.4 SUBMITTALS

.1 Product Data: For each type of product.

.2 Include:

- .1 Heating cable data sheet.
- .2 Connection kits and accessories data sheet.
- .3 Controller data sheet.
- .4 Controller wiring diagram.

.3 Include rated capacities, operating characteristics, and furnished specialties and accessories.

.4 Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.

.5 Include heat loss calculations for each pipe including pipe and insulation characteristics, heat loss, and watts per foot supplied by the heating cable.

.6 Shop Drawings: For electric heating cable.

- .1 Include plans, elevations, and sections.
- .2 Include diagrams for power, signal, and control wiring.
- .3 Manufacturer to produce detailed design as described below.

.7 Design Submittal: Submit signed and sealed design layout drawings by the qualified professional engineer responsible for their preparation. Delegated design submittals include:

- .1 Heat Trace Circuit Layout Drawings, including:
  - .1 Location/Identification of area to be traced.
  - .2 Heater circuit number.
  - .3 Electrical load.
  - .4 Heater catalog numbers.
  - .5 Heater termination points.

.6 Start-up temperature.

.7 Location of all components.

.8 Material list and quantities of all components.

.9 Heating cable layout.

.10 Design parameters.

.11 Insulation type and thickness.

.12 Position of all components.

.13 Material schedule listing all components and quantities used.

.14 Panel ID number.

.8 Minimum heat trace capacity shall be 8 watts per foot irrespective of heat loss calculation.

.9 Pipe Freeze Protection Detail Drawings: Project-specific Detail Drawings, including details showing:

.1 Installation and positioning of all components.

.2 Proper amounts of tracing for valves, pumps, flanges, fittings, instruments, etc.

.3 Junction box layouts.

.10 Control Panel Drawings: Drawings for each control panel shall include the following:

.1 Physical arrangement and detail drawings.

.2 Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices shall be numbered and tagged in accordance with system elementary diagrams.

.11 System Wiring Diagram: Project-specific drawings including:

.1 Interconnect of all major components.

.2 Assignment of circuiting.

.3 Connection of circuit wiring in terminal blocks.

.4 Connection of sensor wiring.

.5 Connection of external alarm wiring.

.12 Controller Setpoint Schedule showing the following:

.1 Circuit addresses.

.2 Circuit set points.

.3 **Circuit alarms and settings**.

.13 Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat-tracing system.

1.5 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

.2 Testing: Completed system test report.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications:

.1 ISO-09001 registered.

.2 Provide products consistent with UL 515A, CSA 22.2 No 130-16, and IEEE 515.1 requirements.

.2 Installer Qualifications:

.1 System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.

.2 Electrical connections to be performed by licensed electrician.

.3 Certification: System (Heating Cable and Connection Kits): c-UL-us Listed for freeze protection of standpipes, mains, and branch fire sprinkler piping.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Deliver products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:

.1 Product and Manufacturer.

.2 Length/Quantity.

.3 Lot Number.

.4 Installation and operation Manual.

.5 Material Safety Data Sheet (MSDS).

.2 Store heating cable in clean, dry location with a temperature range of -18° to 60 C (0 to 140 F).

.3 Protect heating cable ends from moisture ingress until final termination of the heating cable is complete.

1.8 WARRANTY

.1 Manufacturer Limited Warranty: Manufacturer agrees to repair or replace heat tracing products listed below that fail in materials or workmanship within specified warranty period.

.2 Covered Products Include:

.1 Heating cables, connection kits, and accessories.

.2 Thermostats, controllers, panels, contactors, sensors, and accessories.

.3 Warranty Period: Two years from date of Ready for Takeover.

.4 Manufacturer's Extended Warranty: Provide Owner an extended product warranty for heat-tracing products for a period of 10 years from date of Ready for Takeover.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Complete pipe freeze protection system for insulated pipes exposed to the risk of freezing. System consists of a self-regulating heating cable, connection kits, accessories, and energy-efficient control and monitoring controller. The heating cable shall have a polyolefin jacket for aboveground fire sprinkler piping, including standpipes, mains, and branch fire sprinkler piping. The monitoring controller must be suitable for integration into the BAS.

2.2 PERFORMANCE REQUIREMENTS

.1 Manufacturer to design complete and functional heat-tracing system. Design must be signed and sealed by a professional engineer.

2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES (TYPE-1)

.1 Basis of design product: Raychem or nVent XL-Trace.

.2 Comply with UL 515A, CSA 22.2 No 130-16, and IEEE 515.1 requirements.

.3 Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Cable shall be capable of crossing over itself once without overheating.

.4 Electrical Insulating Jacket: Flame-retardant modified polyolefin.

.5 Ground Braid: Tinned-copper braid. Minimum 70 percent for ground path and mechanical ruggedness.

.6 Outer Jacket: Modified polyolefin with ultraviolet inhibitor**.** Outer jacket to be printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).

.7 Maximum Operating Temperature (Power On): 68 C (154 F) for and **8 W/ft. (26 W/m)** was required to suit load.

.8 Maximum Exposure Temperature (Power Off): 85 C (185 F).

.9 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

.10 Capacities and Characteristics:

- .1 Nominal Heat Output at 10 C (50 F): 8 W/ft. (26° W/m) minimum. Provide higher as required based on heat loss calculations.
- .2 Piping Diameter: Refer to plans.
- .3 Electrical Characteristics for Single-Circuit Connection:
  - .1 Volts: 120
  - .2 Phase: Single.

2.4 HEATING CABLE CONNECTION KITS

.1 Basis-of-Design Product: RAYCHEM; RayClic.

.2 Provide power connections, splices/tees, and end seal kits to properly connect and terminate heating cable circuit along specified length of piping.

.3 Install splices, tees, and crosses underneath pipe insulation with service loops installed to allow for future service of piping.

.4 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require cutting into heating-cable core to expose bus wires.

.5 Certification: c-UL-us Listed

.6 Locate connection kits above grade for buried applications.

2.5 ACCESSORIES

.1 Cable Installation Accessories: Fiberglass tape, cable ties, connection kits, and end seals all furnished by manufacturer or as recommended in writing by manufacturer.

.2 Identification: Provide and install "Electric Heat Traced" labels on exterior of pipe insulation every 10 ft. (3m) on opposite sides of pipe, and on all splices, tees, crosses, and power connections for the entire length of heat traced piping.

.3 Thermal Pipe Insulation:

.1 Pipes to be thermally insulated in accordance with manufacturer's written requirements.

.2 Insulation shall be closed-cell in areas subject to freezing and have a flame/smoke spread rating of 25/50.

2.6 APPROVED MANUFACTURERS

.1 Approved manufacturers shall be:

.1 Chromalox

.2 Raychem

.3 3M

.4 Serge Baril

.5 Heron Cable Ind.

.6 Easy Heat (Emerson)

Part 3 Execution

3.1 INSTALLED LOCATIONS

.1 Install heat trace in all areas indicated on drawings and where subject to freezing. This includes, but is not limited to:

.1 Water piping exposed to freezing.

.2 Sanitary piping exposed to freezing.

.3 Sanitary trap exposed to freezing.

.4 Storm piping exposed to freezing.

.5 Rain water leader discharging to grade outside the building.

.6 Piping placed in an outside wall.

3.2 EXAMINATION

.1 Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

.1 Prior to installation of heating cable system, verify that all piping, to be heat traced has passed all hydrostatic/pressure test and is signed off by plumbing inspector.

.2 Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

.2 Preinstallation Testing:

.1 Prior to installation of heating cable on piping, an insulation resistance test shall be performed by installing contractor to ensure integrity of heating cable as describe in installation and maintenance manual.

.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

.1 Protect all heating cable ends from moisture ingress until cable is terminated with end seals.

.1 Basis-of-Design Product: RAYCHEM; RayClic-E end seals.

3.4 INSTALLATION

.1 Install electric heating cable where indicated and in accordance with NFPA 70 and NFPA 13.

.2 All heat-tracing components including power connections, splices, tees, and crosses or end seal, must be installed above grade and protected from abuse or damage. In accordance with NEC and CEC, electrical connections are not permitted to be installed below grade.

.3 In the field, all heating cables shall be meggered with a minimum of 2,500 V dc for self-regulating cable. The following field megger readings shall be taken on each heating cable:

.1 Heating cable shall be meggered when received at Project site before installation.

.2 Heating cable shall be meggered after installation, but before insulation is installed.

.3 Heating cable shall be meggered after insulation is installed.

.4 Heating cable shall be meggered at final commissioning prior to being energized.

.5 Insulation resistance must exceed 1.000 megohms at 2,500 V dc.

.6 All results must meet manufacturer's specification.

.7 Test cables for electrical continuity during installation.

.8 Test insulation integrity before energizing.

.9 Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

.4 Install electric heating cables after piping has passed all hydrostatic pressure testing and before insulation is installed.

.5 Install electric heating cables in accordance with IEEE 515.1.

.6 Install insulation over piping with electric cables.

.7 Install warning tape on piping insulation where piping is equipped with electric heating cables.

.8 Set field-adjustable switches and circuit-breaker trip ranges.

.9 All heat trace cable shall be fastened to the steel pipes with plastic cable ties or fibreglass tape.

.10 The cable shall run the entire length of each pipe linearly.

.11 Power connection kits shall be installed in a weatherproof surface mounted junction box (suitable to house the connection kit) in the location shown on the drawings.

.12 Provide two runs of cable along the length of piping for all piping greater than or equal to 150mm (6" diameter). Run cable along top and bottom of entire pipe length or as per manufacturer’s recommendations.

.13 Electrical Division shall provide power to junction box adjacent to heat trace circuit power connection. All other wiring shall be by this contractor to the standards of the Electrical Division.

3.5 CONNECTIONS

.1 Ground equipment to the requirements of the Electrical Division.

.2 Connect wiring in accordance with the requirements of the Electrical Division.

.3 Connect heat-tracing controls to fire-alarm system in accordance with NFPA 13. Comply with requirements of the Electrical Division.

3.6 FIELD QUALITY CONTROL

.1 Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system shall be performed by factory technician.

.1 System shall be commissioned in accordance with manufacturer’s installation and operation manual.

.2 Field Visits to be scheduled at the following intervals:

.1 Preinstallation training.

.2 Final electrical insulation resistance (megger) testing of heating cable after insulation has been installed.

.3 Final commissioning including controller programming (if applicable).

.3 Technician to verify:

.1 Controller parameters are set to the application requirements.

.2 Controller alarm contacts are properly connected to the BMS, as applicable.

.4 Test cables for electrical continuity during installation.

.5 Test insulation integrity before energizing.

.6 Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

.2 Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

.3 Cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's testing requirements.

.4 Prepare test and inspection reports.

3.7 PROTECTION

.1 Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.

.2 Remove and replace damaged heat-tracing cables.

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 Proprieties by Means of the Guarded Hot-Plate Apparatus.

.4 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Proprieties 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.

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	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	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Horizontal Cast Iron Sanitary Piping	A-1		N/A	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/AWWA B301, Liquid Chlorine.

.3 ANSI/AWWA C104/A21.4, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.

.4 ANSI/AWWA C205, Cement Mortar Protective Lining and Coating for Steel Water Pipe - 4 inch and larger - Shop Applied.

.5 ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service, 4 inch through 144 inch.

.6 ANSI/AWWA C500, Metal-seated Gate Valves for Water Supply Service.

.7 ANSI/AWWA C600, Installation of Ductile Iron Water Mains, and their Appurtenances.

.8 ANSI/AWWA C800, Underground Service Line Valves and Fittings.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general division.

1.3 AS-BUILT DRAWINGS

.1 Provide Data to produce as-built drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details, maintenance and operating instructions in accordance with Submittals Section.

1.4 SCHEDULING OF WORK

.1 Schedule work to minimize interruptions to existing services. Interruptions during school hours will not be allowed.

.2 Submit schedule of expected interruptions to Consultant for approval and adhere to interruption schedule as approved by Consultant.

.3 Notify building occupants' minimum of 24 h in advance of any interruption in service.

.4 Do not interrupt water service for more than 3 h and confine this period between 16:00 and 6:00 h local time or weekends unless otherwise authorized.

.5 Notify fire department of any planned or accidental interruption of water supply to hydrants.

.6 Advise local police department of anticipated interference with movement of traffic.

.7 Notify owner's security company with any interruptions.

Part 2 Products

2.1 PIPES, JOINTS AND FITTINGS

.1 Ductile iron pipe: to ANSI/AWWA C151/A21.51, class 52 cement mortar lined to ANSI/AWWA C104/A21.4.

.1 Acceptable material: HYPROTEC

.2 P.V.C. pipe: to AWWA C900, CSA B137.2, ASTM, class 150 P.V.C. (DR18).

.1 Acceptable material: Blue Brute or Equal.

.3 Joints and fittings for ductile iron pipe:

.1 Joints:

.1 Rubber gasket for mechanical pipe joints: to ANSI/AWWA C111/A21.11.

.2 Rubber gasket for flange pipe joints 1.6 mm thick: to ANSI/AWWA C111/A21.11.

.3 Bolts, nuts, hex head with washers: to ASTM A307, heavy series.

.4 Ensure electrical conductivity across joints.

.2 Fittings:

.1 Mechanical joint cast iron and ductile iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.

.2 Flanged cast iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.

2.2 FITTINGS AND SPECIALTIES

.1 All fittings and specials shall be installed where shown or where ordered by the Engineer. Fittings subject to lateral thrust or “blow-out” shall be properly supported by cast-in-place thrust blocks of 25 Mpa concrete placed against undisturbed earth in accordance with the contract drawings. Where necessary, when working in unstable ground conditions or when installing vertical bends, the contractor shall use anchor blocks with anchor rods, or tie rods connected to the closest solid joint, to assure proper support against “blow-out”.

2.3 PIPE BEDDING AND SURROUND MATERIAL

.1 Granular material to Aggregates: General and following requirements:

.1 Crushed or screened stone, gravel or sand.

.2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117 Sieve sizes to CAN/CGSB-8.1.

.2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Cast-in-Place Concrete Section.

2.4 BACKFILL MATERIAL

.1 As indicated.

.2 Type 3, in accordance with Excavating, Trenching and Backfilling.

2.5 PIPE DISINFECTION

.1 Liquid chlorine to ANSI/AWWA B301 to disinfect water mains.

Part 3 Execution

3.1 PREPARATION

.1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects. Remove defective materials from site.

3.2 TRENCHING

.1 Do trenching work in accordance with Excavating Trenching and Backfilling Section.

.2 Trench depth to provide cover over pipe of not less than1.85 m from finished grade.

3.3 GRANULAR BEDDING

.1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth of 150 mm below bottom of pipe to depth as indicated.

.2 Do not place material in frozen condition.

.3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.

.4 Shape transverse depressions in bedding as required to suit joints.

.5 Compact each layer full width of bed to at least 95% of corrected maximum dry density and 95% maximum density to ASTM D698.

.6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Excavating Trenching and Backfilling Section.

3.4 PIPE INSTALLATION

.1 **Connect to domestic water and fire main piping installed by site services contractor.** Terminate building water service inside building and 450 mm above finish floor. Install coupling necessary for connection to building plumbing. If plumbing is already installed, make connection; otherwise cap or seal end of pipe.

.2 Lay pipes to ANSI/AWWA C600 and ANSI/AWWA Manual of Practice and manufacturer's standard instructions and specifications. Do not use blocks.

.3 Join pipes in accordance with ANSI/AWWA C600 ANSI/AWWA C602 ANSI/AWWA C206 AWWA Manual of Practice and manufacturer's recommendations.

.4 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.

.5 Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length. Take up and replace defective pipe. Correct pipe, which is not in true alignment or grade or pipe, which shows differential settlement after installation greater than 10 mm.

.6 Face socket ends of pipe in direction of laying. For mains on a grade of 2% or greater, face socket ends up-grade.

.7 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.

.8 Keep jointing materials and installed pipe free of dirt and water and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.9 Position and join pipes with equipment and methods approved by Consultant.

.10 Cut pipes in an approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

.11 Align pipes carefully before jointing.

.12 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

.13 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed or contaminated shall be removed, cleaned, lubricated and replaced before jointing is attempted again.

.14 Complete each joint before laying next length of pipe.

.15 Minimize deflection after joint has been made.

.16 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.

.17 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Engineer.

.18 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.

.19 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.

.20 Do not lay pipe on frozen bedding.

.21 Do hydrostatic and leakage test and have results approved by Consultant before surrounding and covering joints and fittings with granular material.

.22 Backfill remainder of trench.

3.5 THRUST BLOCKS

.1 Install thrust blocks to OPS standards for roads and municipal services.

.2 Concrete shall be placed to within 50 mm of the face of the bell.

.3 Bond breaker shall be used between the fittings and concrete.

3.6 HYDROSTATIC AND LEAKAGE TESTING

.1 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.

.2 Notify Consultant at least 24 h in advance of all proposed tests. Perform tests in presence of Consultant.

.3 Where any section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.

.4 Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated or directed by Consultant.

.5 Leave hydrants, valves, joints and fittings exposed.

.6 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.

.7 Open valves.

.8 Expel air from main by slowly filling main with potable water. Install corporation stops at high points in main where no air-vacuum release valves are installed. Remove stops after satisfactory completion of test and seal holes with plugs.

.9 Thoroughly examine exposed parts and correct for leakage as necessary.

.10 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.

.11 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.

.12 Do not exceed allowable leakage of 0.03 L/mm diameter per 300 m of pipe, including lateral connections, per hour.

.13 Locate and repair defects if leakage is greater than amount specified.

.14 Repeat test until leakage is within specified allowance for full length of watermain.

3.7 PIPE SURROUND

.1 Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes as indicated.

.2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.

.3 Place layers uniformly and simultaneously on each side of pipe.

.4 Do not place material in frozen condition.

.5 Compact each layer from pipe invert to mid height of pipe to at least 95% of corrected maximum dry density.

.6 Compact each layer from mid height of pipe to underside of backfill to at least 90% of corrected maximum dry density.

3.8 BACKFILL

.1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.

.2 Do not place backfill in frozen condition.

.3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density. In other areas, compact to at least 90% corrected maximum dry density.

3.9 FLUSHING AND DISINFECTING

.1 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.

.2 Flushing flows shall be as follows:

Pipe Size NPS	Flow (L/s) Minimum
6 and below	38
8	75
10	115
12	150

.3 Provide connections and pumps for flushing as required.

.4 Open and close valves, hydrants and service connections to ensure thorough flushing.

.5 When flushing has been completed to satisfaction of Consultant, introduce a strong solution of chlorine as approved by authority having jurisdiction into watermain and ensure that it is distributed throughout entire system.

.6 Rate of chlorine application to be proportional to rate of water entering pipe.

.7 Chlorine application to be close to point of filling water main and to occur at same time.

.8 Operate valves, hydrants and appurtenances while main contains chlorine solution.

.9 Flush line to remove chlorine solution after 24 h.

.10 Measure chlorine residuals at extreme end of pipe-line being tested.

.11 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 recur during this period, repeat disinfecting procedure. Specialist contractor shall submit certified copy of test results.

.12 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.

.13 After 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.

3.10 SURFACE RESTORATION

.1 After installing and backfilling over water mains, restore surface including all roads, curbs, sidewalks, landscaped areas etc. to original condition and to standards of local authority having jurisdiction.

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 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.

.11 MSS-SP-67, Butterfly Valves.

.12 CSA B137.1 Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services.

.13 CSA B137.5, cross linked polyethylene (PEX) tubing systems for pressure applications.

.14 ASTM International

- .1 ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing
- .2 ASTM F877 Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems
- .3 ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing

.15 German Institute for Standards (Deutsches Institut fur Normung e.V., DIN)

- .1 DIN 4726 Warm Water Surface Heating Systems and Radiator Connecting Systems – Plastics Piping Systems and Multilayer Piping Systems.

.16 National Sanitation Foundation (NSF) International

- .1 NSF-rfh: Evaluated for use in Radiant Floor Heating (NSF-rfh) Applications

.17 Canadian Standards Association (CSA)

- .1 CAN/CSA B137.5 Standard Specification for Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications

.18 Uponor, Inc.

- .1 Uponor Pre-insulated Pipe Systems Design and Installation Manual, current edition

Part 2 Products

2.1 COPPER PIPING

.1 PIPING

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

.1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.

.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.

.6 NPS 80 mm (3") and larger: roll grooved to CSA B242.

.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.

.6 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.

.7 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM flush seal gasket.

.4 VALVES

.1 All valves shall be of commercial grade and of same manufacturer.

.2 Acceptable Manufacturers:

.1 Milwaukee

.2 Crane

.3 Neuman Hattersley

.4 Kitz

.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.

.6 GATE VALVES

.1 NPS 50 mm (2") and under, soldered:

.1 Rising stem: to MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, screw-in bonnet, solid wedge disc.

.2 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.

.3 NPS 65 mm (2-1/2") and over, in mechanical rooms, flanged:

.1 Rising stem: to MSS SP-70, Class 125, 860 kPa (125 psi), flat flange faces, cast-iron body, OS&Y bronze trim.

.4 NPS 65 mm (2-1/2") and over, other than mechanical rooms, flanged:

.1 Non-rising stem: to MSS SP-70, Class 125, 860 kPa (125 psi), flat flange faces, cast-iron body, bronze trim, bolted bonnet.

.7 GLOBE VALVES

.1 NPS 50 mm (2") and under, soldered:

.1 To MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, renewable composition disc, screwed over bonnet.

.2 Lockshield handles: as indicated.

.2 NPS 50 mm (2") and under, screwed:

.1 To MSS SP-80, Class 150, 1.03 MPa (150 psi), bronze body, screwed over bonnet, renewable composition disc.

.2 Lockshield handles: as indicated.

.8 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.

.3 NPS 65 mm (2 1/2") and over, flanged:

.1 To MSS SP-71, Class 125, 860 kPa (125 psi), cast iron body, flat flange faces, [regrind] [renewable] seat, bronze disc, bolted cap.

.9 BUTTERFLY VALVES

.1 Provide copper tubing grooved valves where indicated.

.2 NPS 100 mm (4") and over:

.1 Bronze body per CDA-836.

.2 EPDM/Bronze disk and trim.

.3 Two position handle.

.4 Acceptable Manufacturers:

.1 Victaulic Series 608

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.

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 CAN/CSA – B64.10/B64.10.1 – Selection and Installation of Backflow Preventers/Maintenance and Field Testing of Backflow Preventers.

1.2 SUBMITTALS

.1 Complete the required cross connection survey form and submit to authority having jurisdiction. Provide a copy to the consultant.

.2 Incorporate data into maintenance manual.

Part 2 Products

2.1 GENERAL

.1 Provide backflow prevention devices in all new and existing fixtures and equipment as indicated and as required by the authority having jurisdiction.

.2 Acceptable Manufacturers:

.1 Watts

.2 Wilkins

Part 3 Execution

3.1 INSTALLATION

.1 Install devices in accordance with acceptable engineering practices, the requirements of the Ontario Building Code and the requirements of the authority having jurisdiction.

3.2 TESTING

.1 Provide testing to requirements of authority having jurisdiction.

.2 Provide copy of test report for each device in the maintenance manual.

.3 Provide tag on each device.

.4 Provide a list of devices complete with tag number on a framed chart. Locate chart in Water Entrance Room.

.5 Provide additional testing on all devices at one year warranty period. Provide documentation to owner and consultant.

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 (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

2.2 INTERIOR HOSE BIBB

.1 20 mm (3/4") 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

2.3 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

2.4 BACKFLOW PREVENTORS

.1 General Requirements:

.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.

.2 Reduced Pressure Principle:

.1 Up to 50 mm (2"):

.1 Rated to 180°F and supplied with full port ball valves. The main body and access covers shall be bronze (ASTM B584), the seat ring and all internal polymers shall be NSF® Listed Noryl™, and the seat disc elastomers shall be SILICONE. The first and second check shall be orientated at a 45° angle up-wards and accessible for maintenance without removing the relief valve. Supplied with an air gap adapter.

.2 Acceptable Manufacturers:

.1 Watts 009 ½" - 2"

.2 Wilkins 975 XL ½" - 2"

.3 Conbraco 40-200 Series

.2 65 mm (2½") to 250 mm (10"):

.1 The reduced pressure principle backflow preventer shall be ASSE 1013 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. The first and second checks shall be accessible for maintenance without removing the relief valve or the entire device from the line.

.2 If installed indoors, the installation shall be supplied with an air gap adapter, strainer, and integral monitor switch.

.3 Acceptable Manufacturers:

.1 Watts 909 2½" - 10"

.2 Wilkins 975 2½"- 10" or 375 4"- 6"

.3 Conbraco 40-200 Series

.3 Double Check Valve Assembly (DCVA):

.1 Up to 50mm (2"):

.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 65 mm (2½") to 250 mm (10"):

.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. The checks shall be accessible for maintenance without removing the device from the line.

.2 Acceptable Manufacturers:

.1 Watts 709 2½" - 10"

.2 Wilkins 950 2" - 10", 350 4" - 6"

.3 Conbraco 40-100 Series

.4 Dual Check Valve with Intermediate Atmospheric Vent:

.1 Application: Laboratory equipment, processing tanks, sterilizers, dairy equipment.

.2 Suitable for continuous pressure applications and both hot and cold water systems.

.3 Primary check valve features check valve with rubber disc seating against a mating rubber part to ensure tight closing.

.4 Secondary check valve utilizes rubber disc to metal contact closing.

.5 In the event of backflow, leaks through the atmospheric vent.

.6 Bronze body, stainless steel working parts with integral strainer.

.7 Sizing: Match line size.

.8 Installation: As per manufacturer instructions, ensure serviceable location. Pipe atmospheric vent to drain. Unit shall be installed surface mounted on wall, not hidden in wall or ceiling.

.9 Acceptable Manufacturers:

.1 Watts Series 9D

.2 Wilkins 750

.3 Conbraco 40-4A Series

.5 Dual Check Valve without Atmospheric Vent:

.1 Application: Non-carbonated beverage filling stations, cooking equipment with domestic water connections.

.2 Suitable for continuous pressure applications and both hot and cold water systems.

.3 Body and adapters are all 316 stainless steel construction.

.4 Rubber components comply with FDA food additive regulations and Safe Drinking Water Act. Bronze body, stainless steel working parts with integral strainer.

.5 Sizing: Match line size.

.6 Installation: As per manufacturer instructions, ensure serviceable location. Install prior to any filters provided with beverage dispenser. Unit shall be installed surface mounted on wall, not hidden in wall or ceiling.

.7 Acceptable Manufacturers:

.1 Watts Series 2D

.2 Wilkins

.3 Conbraco

.6 Recessed Enclosures – DCVA and RP Backflow:

.1 Application: Provide for all DCVA and RP Backflow devices installed outside of service spaces and where indicated on plans.

.2 Size: Suitable for installed devices with appropriate service space for regular testing of device. Provide unit large enough for two devices where two devices are present.

.3 Construction:

.1 304 stainless steel.

.2 Concealed hinge access door complete with viewing window.

.3 Access door to have hasped/locking closure mechanism.

.4 Side or top/bottom openings to suit domestic water connections.

.5 Bottom opening for 50 mm (2") drain port.

.4 Acceptable Manufacturer:

.1 Emerson ValvCheQ.

.2 Others as approved by Consultant prior to tender close.

2.5 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

2.6 PRESSURE REGULATORS

.1 Capacity: as indicated.

.1 Inlet pressure: 1034 kPa (150 psi).

.2 Outlet pressure: 41 kPa (5.9 psi).

.2 Up to NPS 40 mm (1 1/2") bronze bodies, screwed: to ASTM B62.

.1 Acceptable Manufacturers:

.1 Watts Series 25AUB (1/2" - 2")

.3 NPS 50 mm (2") and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class [B].

.1 Acceptable Manufacturers:

.1 Watts PV-10

.2 Conbraco 36 Series

.4 Semi-steel spring chambers with bronze trim.

.1 Acceptable Manufacturers:

.1 Watts PV-10

.2 Conbraco 36 Series

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 MAKE-UP ASSEMBLY

.1 Complete with backflow preventor, pressure gauge on inlet and outlet, pressure reducing valve to CSA B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.

.1 Acceptable Manufacturers:

.1 Watts

.2 Conbraco

2.9 WATER METERS (CHECK METERS)

.1 To latest AWWA Standard C700-77

.2 Direct reading registrar, cast bronze main case, positive displacement.

.3 Acceptable Manufacturers:

.1 Neptune t-10

2.10 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

2.11 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

2.12 SOLENOID VALVES

.1 Two (2) way normally closed all bronze construction.

.2 Voltage shall be suitable for controlling function.

.3 Acceptable Manufacturers:

.1 Asco

2.13 OWNER SUPPLIED EQUIPMENT

.1 The mechanical contractor shall supply and install all water, gas, condensate and sanitary piping to the owner supplied equipment. Connection to equipment shall be by this contractor.

.2 Provide flexible riser stops to all sinks and ball valves to all other equipment.

.3 Provide backflow preventors on equipment required by the local plumbing inspector.

.4 Provide flexible gas piping to all gas equipment.

.5 All equipment in store equipment schedule will be supplied and set in place by Mechanical Contractor unless otherwise noted.

.6 Coordinate all rough-ins and connection with the supplier on site.

.7 Owner supplied equipment includes existing relocated equipment.

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 WATER HAMMER ARRESTORS

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

3.4 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.

3.5 HOSE BIBBS AND SEDIMENT FAUCETS

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

3.6 STRAINERS

.1 Install with sufficient room to remove basket.

.2 Strainer size to match pipe size.

3.7 WATER METERS

.1 Install water meter provided by local water authority **and/or this contractor.**

.2 Install water meter as indicated.

.3 Install remote readout to acceptance of local water authority and as indicated.

.4 Install check meter(s) as indicated.

3.8 WATER MAKE-UP ASSEMBLY

.1 Install with valved bypass.

.2 Pipe discharge from relief valve to nearest floor drain.

3.9 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.

3.10 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 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ASTM C117, Test Method for Material Finer Than 0.075 mm (3 mil) Sieve in Mineral Aggregates by Washing.

.3 ASTM C136, Method for Sieve Analysis of Fine and Coarse Aggregates.

.4 ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m3).

.5 ASTM D2680, Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.

.6 ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

.7 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

.8 CAN/CSA-B182.2, PVC Sewer Pipe and Fittings (PSM Type).

.9 CSA B182.11, Standard Practice for the Installation of Thermoplastic Drain and Sewer, Storm Pipe and Pipe Fittings.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Submittals Section.

1.3 MATERIAL CERTIFICATION

.1 Submit manufacturers test data and certification at least 2 weeks prior to commencing work.

1.4 SCHEDULING OF WORK

.1 Schedule work to minimize interruptions to existing services and to maintain existing sewage flows during construction.

.2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

.3 Notify the building manager a minimum of 24 hrs in advance of any interruption in service.

Part 2 Products

2.1 PLASTIC PIPE

.1 Type PSM Polyvinyl Chloride (PVC): to ASTM D3034 or CAN/CSA-B182.2.

.1 Standard Dimensional Ratio SDR 28 35 41.

.2 Locked in gasket and integral bell system.

.3 Nominal lengths: 6 m (20').

2.2 CEMENT MORTAR

.1 Portland cement: to CAN/CSA-A300 Series, normal type 10.

.2 Mix mortar one part by volume of cement to two parts of clean, sharp sand mixed dry. Add only sufficient water after mixing to give optimum consistency for placement. Do not use additives.

2.3 PIPE BEDDING AND SURROUND MATERIALS

.1 Granular material to Excavating, Trenching, and Backfilling Section: and following requirements:

.1 Crushed or screened stone, gravel or sand.

.2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117]. Sieve sizes to CAN/CGSB-8.1.

	Stone/Gravel	Gravel/Sand
200 mm (8")	-	-
75 mm (3")	-	-
50 mm (2")	-	-
40 mm (1 1/2")	-	-
25 mm (1")	100	-
20 mm (3/4")	-	-
15 mm (1/2")	65-90	100
10 mm (3/8")	-	-
5 mm (3/16")	35-55	50-100
2.00 mm (80 mil)	-	30-90
0.425 mm (16 mil)	10-25	10-50
0.180 mm (7 mil)	-	-
0.075 mm (3 mil)	0-8	0-10

.2 Concrete mixes and materials for cradles, encasement, and supports: to Cast-in-Place Concrete Section.

2.4 BACKFILL MATERIAL

.1 As indicated.

.2 Type 3, in accordance with Excavating, Trenching and Backfilling Section.

.3 Unshrinkable fill: to Excavating, Trenching and Backfilling Section.

2.5 FORCED MAINS

.1 Polyvinyl chloride (PVC) pipe: to CAN/CSA-B137.3 and ANSI/AWWA C900.

.1 Acceptable Manufacturers: IPEX Series 125.

.2 SDR: 32.5

.3 Pressure Class: II

.4 Gasket bell end.

.5 Pipe joints: bell and spigot with rubber gaskets solvent welded joints or mechanical joints to ANSI/AWWA C111/A21.11, with transition gaskets to pipe manufacturers specifications.

.6 Rubber gaskets: to ANSI/AWWA C111/A21.11. [Gaskets for mechanical joints to be duck-tipped transition gaskets for PVC].

.7 Fittings: Moulded one piece construction with engineered ribs for 200 psig and gasket joints.

Part 3 Execution

3.1 PREPARATION

.1 Clean and dry pipes and fittings before installation.

3.2 TRENCHING

.1 Do trenching work in accordance with Excavating, Trenching and Backfilling Section.

.2 Do not allow contents of any sewer or sewer connection to flow into trench.

.3 Trench alignment and depth require approval of Consultant prior to placing bedding material and pipe.

3.3 GRANULAR BEDDING

.1 Place bedding in unfrozen condition.

.2 Place granular bedding materials in uniform layer(s) not exceeding 150 mm (6") compacted thickness to depth of 300 mm (12").

.3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipe.

.4 Shape transverse depressions as required to suit joints.

.5 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.

.6 Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

3.4 INSTALLATION

.1 Lay and join pipes in accordance with manufacturer's recommendations.

.2 Handle pipe using methods approved. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.

.3 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.4 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.

.5 Do not exceed maximum joint deflection recommended by pipe manufacturer.

.6 Do not allow water to flow through pipe during construction.

.7 Whenever work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.8 Install plastic pipe and fittings in accordance with CSA B182.11.

.9 Pipe jointing:

.1 Install gaskets in accordance with manufacturer's recommendations.

.2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

.3 Align pipes before joining.

.4 Maintain pipe joints free from mud, silt, gravel and other foreign material.

.5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall be removed, cleaned and lubricated and replaced before joining is attempted.

.6 Complete each joint before laying next length of pipe.

.7 Minimize joint deflection after joint has been made to avoid joint damage.

.8 At rigid structures, install pipe joints not more than 1.5 m (5') from side of structure.

.9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

.10 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

.11 Make watertight connections to manholes. Use shrinkage compensating grout when suitable gaskets are not available.

.12 Use prefabricated saddles or field connections approved by Consultant, for connecting pipes to existing sewer pipes. Joints to be structurally sound and watertight.

3.5 PIPE SURROUND

.1 Place surround material in unfrozen condition.

.2 Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated. Leave joints and fittings exposed until field testing is completed.

.3 Hand place surround material in uniform layers not exceeding 150 mm (6") compacted thickness as indicated. Do not dump material within 1.0 m (40") of pipe.

.4 Place layers uniformly and simultaneously on each side of pipe.

.5 Compact each layer from pipe invert to mid height of pipe to at least 95% maximum density to ASTM D698.

.6 Compact each layer from mid height of pipe to underside of backfill to at least 90% corrected maximum dry density and maximum density to ASTM D698.

.7 When field test results are acceptable to Consultant, place surround material at pipe joints.

3.6 BACKFILL

.1 Place backfill material in unfrozen condition.

.2 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm (6") compacted thickness up to grades as indicated.

.3 Under paving and walks, compact backfill to at least 95% maximum density to ASTM D698. In other areas, compact to at least 90% maximum density to ASTM D698.

3.7 FIELD TESTING GRAVITY DRAINS

.1 Repair or replace pipe, pipe joint or bedding found defective.

.2 When directed by Consultant, draw tapered wooden plug with diameter of 50 mm (2") less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.

.3 Remove foreign material from sewers and related appurtenances by flushing with water.

.4 Perform infiltration and exfiltration testing as soon as practicable after jointing and bedding are complete, and service connections have been installed.

.5 Carry out tests on each section of sewer between successive manholes including service connections.

.6 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.

.7 Exfiltration test:

.1 Fill test section with water in such a manner as to allow displacement of air in line. Maintain under nominal head for 24 h to ensure absorption in pipe wall is complete before test measurements are commenced.

.2 Immediately prior to test period add water to pipeline until there is a head of 1.0 m (40") over interior crown of pipe measured at highest point of test section or water in manhole is 1.0 m (40") above static ground water level, whichever is greater.

.3 Duration of exfiltration test: 2 h.

.4 Water loss at end of test period: not to exceed maximum allowable exfiltration over any section of pipe between manholes.

.8 Repair and retest sewer line as required, until test results are within limits specified.

.9 Repair visible leaks regardless of test results.

3.8 FIELD TESTING FORCED MAINS

.1 Testing of force main to be carried out in the presence of Consultant.

.2 Strut and brace caps, bends and tees, to prevent movement when test pressure is applied.

.3 Expel air from force main, by slowly filling main with water. High points to be drilled and tapped and suitable cocks installed to vent air and to be shut when pressure is applied. Remove cocks after satisfactory completion of test and seal holes with tight fitting plugs.

.4 Apply hydrostatic test pressure of 861 kPa (125 psig) based on elevation of lowest point in line and corrected to elevation of test gauge for hydrostatic test and for leakage test.

.5 Apply pressure for 1 h for pressure test and 2 h for leakage test.

.6 Examine exposed pipe, joints and fittings while system is under pressure.

.7 Remove defective joints, pipe and fittings and replace with new sound material.

.8 Locate and repair defects if leakage is greater than amount specified in item 3.9.9.

.9 Repeat test until leakage is within specified allowance for full length of force main.

.10 Complete backfill.

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.

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 ZXN-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 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

.3 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 ZXN-1612

.2 Mifab C1100-S-6

.3 Watts CO-200-S-1-6

.4 Jay R. Smith SQ-4-1753-NBCO-SP-U-Y

.4 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

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 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.

3.4 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.

3.5 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 Trap seal primers:

.1 Verify operation.

.2 Adjust flow rate to suit site conditions.

.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.

3.6 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.

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^2 (5 lb/ft^2) 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 ASTM D2235, Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.3 ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.4 CAN/CSA-B181.1, ABS Drain, Waste and Vent Pipe and Pipe Fittings.

.5 CAN/CSA-B181.2, PVC and CPVC Drain, Waste and Vent Pipe and Pipe Fittings.

.6 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

Part 2 Products

2.1 PIPING AND FITTINGS

.1 Buried sanitary, and vent piping to:

- .1 80 mm (3") and smaller: ABS drain waste and vent pipe to CAN/CSA-B181.1.
- .2 100 mm (4") and larger: SDR-35 PVC drain waste and vent pipe to CAN/CSA-B181.2.
- .3 Vent piping: any size, PVC-DWV plastic drain and sewer pipe and fittings CAN/CSA-B181.2.

.2 Above grade sanitary and vent piping:

- .1 80 mm (3") and smaller: IPEX: PVC-XFR drain waste and vent pipe to CAN/CSA-B181.2.
- .2 100 mm (4") and larger: IPEX: PVC-XFR drain waste and vent pipe to CAN/CSA-B181.2.
- .3 Vent piping: any size, IPEX: PVC-XFR plastic drain and sewer pipe and fittings CAN/CSA-B181.2.

.3 Use plastic XFR – DWV in pipe chase for urinal piping to 1.5 M (5' –0") above finished floor.

.4 Where piping pierces a fire separation an approved fire stop system to the approval of authority having jurisdiction shall be used.

2.2 JOINTS

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

2.3 EXPANSION

.1 Provide solvent welded expansion joints as required by manufacturer's recommendations.

2.4 VENT FLASHINGS

.1 Thaler Stack Jack spun aluminum complete with insulation, cap, and rubber gasket.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction. Install in accordance with manufacturer's instructions.

.2 Installation of underground pipe

.1 Provide all excavation, bedding, backfill, and compaction.

.2 Install materials in accordance with Manufacturer's instructions.

.3 Use jacks to make-up gasketed joints.

.4 Stabilize unstable trench bottoms.

.5 Bed pipe true to line and grade with continuous support from firm base.

.1 Bedding depth - 100 mm to 150 mm (4" to 6").

.2 Material and compaction to meet ASTM standard noted above.

.6 Excavate bell holes into bedding material so pipe is uniformly supported along its entire length. Blocking to grade pipe is forbidden.

.7 Trench width at top of pipe -

.1 Minimum 450 mm (18") or diameter of pipe plus 300 mm (12"), whichever is greater.

.2 Maximum - Outside diameter of pipe plus 600 mm (24").

.8 Piping and joints shall be clean and installed according to manufacturer's recommendations. Break down contaminated joints, clean seats and gaskets and reinstall.

.9 Do not use back hoe or power equipment to assemble pipe.

.10 Initial backfill shall be 300 mm (12") above top of pipe with material specified in referenced ASTM standard.

.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 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 Fill waste and vent system a minimum of 1.8 m (6') above finished floor with water and show no leaks for 2 hours.

.2 Conduct ball test in presence of consultant to ensure proper grade and clear of obstructions.

.6 Install solvent welded expansion joints as per manufacturer's recommendation. Care is to be taken to accommodate ambient temperatures at time of install.

.7 Vent entire waste system to atmosphere.

.1 Discharge 350 mm (14") 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.

.8 Flash pipes passing through roof with Thaler insulated Stack Jack flashing.

.1 Flashing base shall be at least 600 mm (24") square.

.9 Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.

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.

.5 PDI-WH201, Water Hammer Arresters.

.6 CAN/CSA-B64 Series, Backflow Preventers and Vacuum Breakers.

.7 PDI-G101, Testing and Rating Procedure for Grease Interceptors.

.8 CAN/CSA-B481 Senes12, Grease Interceptors.

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 ENZYMATIC GREASE INTERCEPTORS (STEEL)

.1 Enzymatic type interceptor, tested and rated in accordance with PDI G101, complete with acid resistant interior enamel finish for mounting flush with floor with non-skid covers on floor complete with flow control fitting suitably vented, and extension.

.2 Capacity:

.1 Refer to Schedules.

.2 Flow Rate: 3.15 l/s (50 gpm)

.3 Supply one (1) case of four 1 kg (2.2 lbs) cans of enzyme activator with interceptors.

.4 Provide extensions as required to suit finished floor elevation and installed depth.

.5 Provide secondary flow control devices for all interceptors that serve fixtures installed more than one storey above unit.

.6 Acceptable Manufacturers:

.1 Zurn Z-1170 (Canadian Market)

.2 Mifab (with confirmation of CSA compliance)

.3 Jay R Smith (with confirmation of CSA compliance)

.4 Ancon WD-CSA (-X if extension required / -E 2lbs of Biomix powder)

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 INTERCEPTORS

.1 Install with sufficient space, as indicated, for ease of maintenance.

3.3 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 Grease interceptors:

.1 Activate, using manufacturer's recommended activation procedures and materials.

.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.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ASTM C14M, Specification for Non-reinforced Concrete Sewer, Storm Drain and Culvert Pipe.

.3 ASTM C76M, Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

.4 ASTM C117, Test Method for Material Finer Than 0.075 mm (3 mil) Sieve in Mineral Aggregates by Washing.

.5 ASTM C136, Method for Sieve Analysis of fine and Coarse Aggregates.

.6 ASTM C443M, Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

.7 ASTM D2680, Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.

.8 ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

.9 CAN/CSA-A3001, Cementitious Materials for Use in Concrete.

.10 ASTM C700, Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

.11 CAN/CSA-A257, Standards for Concrete Pipe and Manhole Sections.

.12 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

.13 CAN/CSA-B182.2, PVC Sewer Pipe and Fittings (PSM Type).

.14 CSA B182.11, Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Pipe Fittings.

.15 CAN/CGSB-8.1, Sieves Testing, Woven Wire.

.16 CAN/CGSB-8.2, Sieves Testing, Woven Wire, Metric.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Submittals Section.

1.3 MATERIAL CERTIFICATION

.1 Submit manufacturers test data and certification at least 2 weeks prior to commencing work.

1.4 SCHEDULING OF WORK

.1 Schedule work to minimize interruptions to existing services and to maintain existing flow during construction.

.2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

1.5 STANDARDS

.1 To local Municipal Standards.

.2 To Ontario Provincial Standards (OPS) for Roads and Municipal Services.

Part 2 Products

2.1 CONCRETE PIPE

.1 Non-reinforced circular concrete pipe and fittings: to CAN/CSA-A257, ASTM C14M 300 mm (12") and smaller diameter, Class 100D, designed forflexible rubber gasket joints to ASTM C443M CSA A257.

.2 Reinforced circular concrete pipe and fittings: to CAN/CSA-A257, ASTM C76M 450 mm (18") and larger diameter, strength classification 100 D, designed for flexible rubber gasket joints to ASTM C443M CAN/CSA A257.

2.2 PLASTIC PIPE

.1 Large diameter, ribbed PVC sewer pipe and fittings: to CAN/CSA B182.4 ASTM F794.

.1 Standard dimension ratio SDR 35

.2 Gasket and integral bell system

.3 Nominal length 6 m (20').

2.3 PIPE BEDDING AND SURROUND MATERIAL

.1 Granular material to Excavating, Trenching, and Backfilling Section and following requirements:

.1 Crushed or screened stone, gravel or sand.

.2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

	Stone/Gravel	Gravel/Sand
200 mm (8")	-	-
75 mm (3")	-	-
50 mm (2")	-	-
40 mm (1 1/2")	-	-
25 mm (1")	[100]	-
20 mm (3/4")	-	-
15 mm (1/2")	[65-90]	[100]
10 mm (3/8")	-	-
5 mm (3/16")	[35-55]	[50-100]
2.00 mm (80 mil)	-	[30-90]
0.425 mm (16 mil)	[10-25]	[10-50]
0.180 mm (7 mil)	-	-
0.075 mm (3 mil)	[0-8]	[0-10]

.2 Concrete mixes and materials for bedding, cradles, encasement, and supports: to Cast-in-Place Concrete Section.

2.4 BACKFILL MATERIAL

.1 As indicated.

.2 Type 3 to Excavating Trenching and Backfilling Section.

Part 3 Execution

3.1 PREPARATION

.1 Clean pipes and fittings of debris and water before installation and remove defective materials from site to approval of Consultant.

3.2 TRENCHING

.1 Do trenching work in accordance with Excavating, Trenching and Backfilling Section.

.2 Do not allow contents of any sewer or sewer connection to flow into trench.

.3 Trench alignment and depth to approval of Consultant prior to placing bedding material and pipe.

3.3 GRANULAR BEDDING AND PIPE SURROUND

.1 Place bedding in unfrozen condition.

.2 Place granular bedding material in uniform layers not exceeding 150 mm (6") compacted thickness to depth of as indicated.

.3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipes.

.4 Shape transverse depressions as required to suit joints.

.5 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.

.6 Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted bedding material.

.7 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated. Do not dump material within 1.0 m of pipe.

.8 Compact each layer from native material to 300 mm (12") above pipe to at least 95% corrected maximum dry density.

3.4 INSTALLATION

.1 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Consultant.

.2 Handle pipe using methods approved by Consultant. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.

.3 Lay pipes on prepared bed, true to line and grade with pipe inverts smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.4 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.

.5 Do not exceed maximum joint deflection recommended by pipe manufacturer.

.6 Do not allow water to flow through pipes during construction.

.7 Install plastic pipe and fittings in accordance with CSA B182.11.

.8 Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

.9 Make watertight connections to manholes and catch basins. Use shrinkage compensating grout when suitable gaskets are not available.

.10 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes. Joint to be structurally sound and watertight.

.11 Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

3.5 PIPE SURROUND

.1 Place surround material in unfrozen condition.

.2 Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated. Leave joints and fittings exposed until field testing is completed.

.3 Hand place surround material in uniform layers not exceeding 150 mm (6") compacted thickness as indicated. Do not dump material within 1.0 m (40") of pipe.

.4 Place layers uniformly and simultaneously on each side of pipe.

.5 Compact each layer from pipe invert to mid height of pipe to at least 95% corrected maximum dry density.

.6 Compact each layer from mid height of pipe to underside of backfill to at least 90% corrected maximum dry density.

.7 When field test results are acceptable to Consultant, place surround material at pipe joints.

3.6 BACKFILL

.1 Place backfill material in unfrozen condition.

.2 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm (6") compacted thickness up to grades as indicated.

.3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density maximum density to ASTM D698. In other areas, compact backfill to at least 90% maximum density to ASTM D698.

3.7 FIELD TESTING

.1 Repair or replace pipe, pipe joint or bedding found defective.

.2 When directed by Consultant, draw tapered wooden plug with diameter of 50 mm (2") less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.

.3 Remove foreign material from sewers and related appurtenances by flushing with water.

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 storm 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 ground storm minimum NPS 80 mm (3"), cast iron to: CAN/CSA-B70.

- .1 Mechanical joints (storm)
  - .1 Heavy duty neoprene or butyl rubber compression gaskets to: ASTM C1540.
  - .2 Stainless steel clamps (4 band min).

Part 3 Execution

3.1 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 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.

.5 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 ASTM D2235, Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.3 ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.4 CAN/CSA-B181.1, ABS Drain, Waste and Vent Pipe and Pipe Fittings.

.5 CAN/CSA-B181.2, PVC and CPVC Drain, Waste and Vent Pipe and Pipe Fittings.

.6 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

Part 2 Products

2.1 PIPING AND FITTINGS

.1 Buried storm piping to:

.1 80 mm (3") and smaller: ABS drain pipe to CAN/CSA-B181.1.

.2 100 mm (4") and larger: SDR-35 PVC drain pipe to CAN/CSA-B181.2.

.2 Above grade storm piping:

.1 80 mm (3") and smaller: IPEX: PVC-XFR fire rated drain storm pipe to CAN/CSA-B181.1.

.2 100 mm (4") and larger: IPEX: PVC-XFR storm pipe to CAN/CSA-B181.2.

.3 Where piping pierces a fire separation an approved fire stop system to the approval of authority having jurisdiction shall be used.

2.2 JOINTS

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.

.2 Installation of underground pipe

.1 Provide all excavation, bedding, backfill, and compaction.

.2 Install materials in accordance with Manufacturer's instructions.

.3 Use jacks to make-up gasketed joints.

.4 Stabilize unstable trench bottoms.

.5 Bed pipe true to line and grade with continuous support from firm base.

.1 Bedding depth - 100 mm to 150 mm (4" to 6").

.2 Material and compaction to meet ASTM standard noted above.

.6 Excavate bell holes into bedding material so pipe is uniformly supported along its entire length. Blocking to grade pipe is forbidden.

.7 Trench width at top of pipe -

.1 Minimum 450 mm (18") or diameter of pipe plus 300 mm (12"), whichever is greater.

.2 Maximum - Outside diameter of pipe plus 600 mm (24").

.8 Piping and joints shall be clean and installed according to manufacturer's recommendations. Break down contaminated joints, clean seats and gaskets and reinstall.

.9 Do not use back hoe or power equipment to assemble pipe.

.10 Initial backfill shall be 300 mm (12") above top of pipe with material specified in referenced ASTM standard.

.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 ft) 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 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 Fill waste and vent system a minimum of 1.8 m (6 ft) above finished floor with water and show no leaks for 2 hours.

.2 Conduct ball test in presence of consultant to ensure proper grade and clear of obstructions.

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 ROOF DRAINS

.1 As indicated on schedules.

.2 Type RD-1: controlled flow; cast iron body, under deck clamp and sump receiver to suit roof construction, flashing clamp ring with integral gravel stop, bearing pan, flow control weir assembly, aluminum dome.

.1 Acceptable Manufacturers:

.1 Zurn ZACF121RC

.2 Mifab R1200-F

.3 WATTS RD-100-ABDK (80)

.4 Jay R. Smith 1083-R-C-AD

.3 Type RD-1: standard roof drain with cast iron body with aluminum dome, under-deck clamp to suit roof construction, roof sump receiver, flashing clamp ring with integral gravel stop.

.1 Acceptable Manufacturers:

.1 Zurn ZA-121-ERC

.2 Mifab R1200-BW

.3 Ancon RD-100-BEDK (80)

.4 Smith

.5 Contour C1000DMP

.4 Type RD-1: inverted roof drain with baked epoxy cast iron body membrane clamp secured with plated hardware, gravel stop, aluminum dome, under-deck clamp secured with plated hardware to suit roof construction, adjustable slotted extension to suit installation, and roof sump receiver.

.1 Acceptable Manufacturers:

.1 Zurn

.2 Mifab

.3 Ancon RD-300-CH

.4 Smith

.5 Contour C1080DPM

.5 Type RD-2: canopy roof drain with cast iron body with bronze dome, clamp ring to suit roof construction, 50 mm (2").

.1 Acceptable Manufacturers:

.1 Zurn ZB-180

.2 Mifab

.3 WATTS

.4 Jay R. Smith 1620-B4

.6 Type RD-: standard roof drain with cast iron body with aluminum dome, extension, under-deck clamp to suit roof construction, roof sump receiver, flashing clamp ring with integral gravel stop and side outlet.

.1 Acceptable Manufacturers:

.1 Zurn Z-100-ERC-SO

.2 Mifab

.3 Ancon

.4 Smith

.5 Contour

.7 Parapet Drain: Parapet scupper sleeve, dura-coated cast iron body with fixed position combination membrane flashing flange and clamp and parapet wall face closing. Galvanized coating.

.1 Acceptable Manufacturers:

.1 Zurn Z-198-G-100

.2 Mifab

.3 Watts

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 SQ-A-1753-XNBCO-SP-U

.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 ZXN-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-TS-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-S-1-6

.4 Jay R. Smith 4200-U

.4 Cover for ceramic tile floors: 15 (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 ZXN-1612

.2 Mifab C1100-S-6

.3 WATTS CO-200-RC-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 BACKWATER VALVES

.1 Coated extra heavy cast iron body with bronze seat, revolving bronze flapper (normally open) and threaded cover.

.1 Acceptable Manufacturers:

.1 Zurn Z-1090

.2 Mifab BV1200-R

.3 WATTS BV200

.4 Jay R. Smith 7012

.2 Access: Surface access.
Access pipe with cover: maximum 300 mm (12") depth.
Steel housing with gasketted steel cover.
Concrete access pit with cover, as indicated.

.1 Acceptable Manufacturers:

.1 WATTS BV-230-R

.2 Jay R. Smith SQ-7-4680-420-LXH420

2.4 DOWNSPOUT NOZZLE

.1 All nickel bronze construction threaded body, spout protruding past building face by 90 mm (3 1/2") and decorative wall flange.

.2 Acceptable Manufacturers:

.1 Zurn ZN-199

.2 Ancon RD-940

.3 Smith

2.5 CATCH BASIN

.1 To ASTM C478M, square. 600 mm x 600 mm (24" x 24" x 48").

.2 Depth to meet top and invert elevations plus 300 mm (12") sump.

.3 Concrete Brick Risers: to CAN/CSA-A165 Series.

.4 Frames, gratings, covers to dimensions as indicated and following requirements:

.1 Metal gratings and covers to bear evenly on frames. A frame with grating or cover to constitute one unit.

.2 Gray iron castings: to ASTM A48/A48M, strength class [30B].

.3 Castings: coated with two applications of asphalt varnish.

.4 Catch basin frames and covers heavy duty municipal type.

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 Install roof drains in lowest point of roof. Co-ordinate location with architectural, structural, and mechanical drawings.

3.2 CLEANOUTS

.1 In addition to those required by code, and as indicated, install at base of all soil and waste stacks, and rainwater leaders.

.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.

3.4 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 Roof drains:
  - .1 Verify installation at low points in roof.
  - .2 Verify security and removability of dome.
  - .3 Adjust weirs to suit actual roof slope and meet requirements of design.
  - .4 Verify provision for movement of roof and integrity of roof drain piping system.
- .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.

.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.

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 (WH-1)

.1 To ANSI Z21.10.3/CSA 4.3 with a recovery rate of 859 l/h (277 gal/h) based on 56°C (100°F) rise and 58 kW (199 MBH) input. Efficiency of 94%.

.2 Tank: 378 l (100 gal), glass, lined steel, 692 mm (27¼") dia x 1739 mm (69½") high 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 3 year warranty certificate.

.5 Vent kit complete with wall vent and vent pipe.

.6 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.

.7 Provide neutralizing cartridge for each hot water tank as supplied by equipment manufacturer.

.8 Acceptable materials:

.1 A. O. Smith Cyclone XI BTH-199

.2 Ruud

.3 Bradford White EF-100T-199E

2.2 GAS FIRED HIGH EFFICIENCY WATER HEATER (WH-2)

.1 To ANSI Z21.10.3/CSA 4.3 with a recovery rate of 523 l/h (138 gal/h) based on 56°C (100°F) rise and 35 kW (120 MBH) input. Efficiency of 94%.

.2 Tank: 227 l (60 gal), glass, lined steel, 692 mm (27¼") dia x 1359 mm (53½") high 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 3 year warranty certificate.

.5 Vent kit complete with wall vent and vent pipe.

.6 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.

.7 Provide neutralizing cartridge for each hot water tank as supplied by equipment manufacturer.

.8 Acceptable materials:

.1 A. O. Smith Cyclone XI BTH-120

.2 Ruud

.3 Bradford White

2.3 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: 3 SPEED 124 W (1/6 hp 120/1/60), drip-proof, with thermal overload protection.

.4 Supports: provide as recommended by manufacturer.

.5 Acceptable materials:

.1 Bell & Gossett

.2 Armstrong

.3 Taco

2.3 DOMESTIC HOT WATER CIRCULATING PUMPS (DAYCARE)

.1 Capacity: 0.6 l/s (3 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: 3-SPEED (fhp 120/1/60), drip-proof, with thermal overload protection.

.4 Supports: provide as recommended by manufacturer.

.5 Acceptable materials:

.1 Bell & Gossett

.2 Armstrong

.3 Taco

2.4 THERMOSTATIC WATER CONTROLLER (3 Port - School)

.1 3/4" inlets 1" 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 materials:

.1 Symmons 7-400A-ASB-W

.2 Powers

2.5 THERMOSTATIC WATER CONTROLLER (3 Port - Daycare)

.1 3/4" inlets 3/4" 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 materials:

.1 Symmons 7-200A-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 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 INSTRUCTIONS TO BIDDERS

.1 The HVAC Supplemental Tender Form must be submitted to the architect and consultant (admin@deiassociates.ca) within 2 hours after tender closing. HVAC contractors shall identify all sub-contractors he/she intends to use and must complete all information requested. The requisite information shall be given at the office of the Consultant. Contractor shall sign and date this page and initial and date each page thereafter.

.2 Should the HVAC Supplemental Form not be submitted then the contractor shall use Base Bid manufacturers as listed.

.3 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

.4 SUB-CONTRACTORS

The Contractor shall state below the name of the Sub-contractors he intends to use, which shall not be changed without the consent of the Consultant.

Insulation _____

Sheet Metal _____

TAB _____

BAS Controls _____

.5 The Stipulated Bid Sum shall be for the base bid manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer he intends to use. Where no choice is indicated, the base bid supplier or equipment shall be used.

.6 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified, provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The HVAC Contractor shall not indicate equipment, materials or suppliers which are not listed. If this is done, the base bid supplier shall be used.

.7 Where modifications to the work of other trades are required as a result or part of the alternative offered, include the cost of said modifications in the work.

.8 Submit the following list of Base Bid and alternative suppliers in accordance with the bid requirements:

Spec. Reference Section	**Equipment**	**Base Bid**	**Acceptable Alternate Manufacturer Or Supplier**	**Indicate Manufacturer Or Supplier**
23 05 11	Access Doors	Le Hage	Zurn Acudor Nailor Industries Inc.	
23 05 19	Thermometers	Trerice	Winters Wiess	
23 05 19	Pressure Gauges	Trerice	Winters Wiess	
23 10 13	Duct Insulation	Johns Manville	Knauf Manson	
23 10 19	HVAC Piping Insulation	Knauf	Manson Owens Corning	
23 11 23	Regulators	Singer	Schlumberger	
23 21 11	Low Water Cut-Off (WRDSB)	Hydro Level Company Safgard 500 or 550		
23 21 13	Valves	Newman Hattersley Canada Ltd.	Jenkins/Crane Milwaukee Toyo Kitz	

CONTRACTOR'S NAME:_____ DATE:_____

Spec. Reference Section	**Equipment**	**Base Bid**	**Acceptable Alternate Manufacturer Or Supplier**	**Indicate Manufacturer Or Supplier**
23 21 13	Balancing Valves	Bell & Gossett Circuit Setters	Armstrong Taco Tour & Anderson Oventrop	
23 21 13	Triple Duty Valve	Bell & Gossett	Armstrong	
23 21 14	Balancing Valves	Tour & Anderson		
23 21 14	Automatic Air Vent	Maid-O-Mist	Spirax Sarco	
23 32 13	Prefabricated Plenums	Vibron	BVA Systems VAW Systems IAC Acoustics	
23 32 13	Acoustic Sound Plenums	BVA Systems	Vibron VAW Systems IAC Acoustics	
23 33 13	Spin-in Collar	Ecco Manufacturing	Flex Master	
23 33 14	Multi-Bladed Dampers & Locking Quadrants	Duro Dyne	E.H. Price Nailor T.A. Morrison Tamco Ruskin Ventex/Alumavent United Enertech Ductmate Pottorff	

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
23 37 23	Louvres/Brick Vents	Greenheck	Construction Specialties Airolite Co. Krueger Ventex Ruskin Ventmaster Nailor Carnes GLAB Penn Barry Pottorff E.H. Price	
23 05 11	Fire Stopping	Minnesota Mining & Manufacturing	Fryesleeve Industries Inc. General Electric Pensil Firestop Systems International Protective Coatings Corp. Rectorseal Corporation (Metacaulk) Proset Systems 3M AS Systems Hilti	
23 05 48	HVAC Seismic Restraint	Member of VISCMA	Kinetics Noise Control Inc. Cooper 'B' Line Unistrut Building Systems Mason Industries	
23 05 49	Vibration Control Measures	Korfund	Vibro-Acoustics Vibron IAC Acoustics	

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
23 06 33	Heat Tracing for HVAC Piping	Chromalox	Raychem 3M Serge Baril Heron Cable Ind. Easy Heat (Emerson)	
23 21 11	Bladder Type Expansion Tank	Amtrol	Armstrong Bell & Gossett	
23 33 16	Fire Dampers	Ruskin	Nailor E.H. Price Ventox/Alumavent United Enertech Safeair-Dowco T.A. Morrison Greenheck Pottorff Tamco	
23 33 17	Smoke Control Dampers	E.H. Price	NCA Ltd. Nailor Industries Ruskin Alumavent United Enertech Safeair-Dawco (stainless steel) Pottorff	
23 33 18	Motorized Dampers	Honeywell	Johnson T.A. Morrison E.H. Price Tamco Ruskin Nailor Henderson Industrial Ventex/Alumavent Pottorff	

Spec. Reference Section	**Equipment**	**Base Bid**	**Acceptable Alternate Manufacturer Or Supplier**	**Indicate Manufacturer Or Supplier**
23 33 19	Silencers	Vibro Acoustics	BVA Systems Vibron VAW Systens IAC Acoustics	
23 34 23	Packaged Exhausters	Greenheck	Penn-Barry Cook Jenn/Jenco (S&P) Carnes Acme Zonex Nutone (Range hood) Broan (Range hood) Twin-City Reversomatic Fantech Aerovent	
23 34 41	High Volume, Low Speed Fans	Basco Canada		
23 34 41	Destratification Fans & Controls (Bucket Fan)	CANARM		
23 36 16	VAV/VVT Boxes	E.H. Price	Nailor Titus Krueger Carnes Metalaire Barber Colman	
23 37 13	Grilles and Diffusers	E.H. Price	Nailor Krueger Titus Carnes Seiho Metalaire Tuttle and Bailey	

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
23 51 33	Insulated Sectional Chimneys	Pro Tech Systems, Inc.	Van Packer Z-Flex Model Cheminée Lining Selkirk/Ampco Security Chimneys International ICC Chimney VIP	
23 81 19	LAN Room Air Conditioners	Daikin	Mitsubishi LG	
23 82 19	Fan Coil Unit	Carrier	Lennox Trane USA Coil	
23 82 29	Radiators, Convectors, and Cabinet Heaters	Engineered Air	Sigma Slant Fin Dunham Bush Rittling	
23 82 31	Radiant Ceiling Panels	Airtex	Epsilon Frenger Sigma Sun-El Armstrong Airtite	
23 82 32	Hydronic Panel Radiator	Runtal	Sterling Rittling	
23 21 23	Circulators	Bell & Gossett	Armstrong	
23 52 13	Stainless Steel Condensing Boilers	Lochinvar	Patterson-Kelly	
23 57 19	Heat Exchangers	Bell & Gossett		
23 64 23	Scroll Water Chillers (Air Cooled)	Carrier	Daikon	
23 72 13	Heat Wheel Air to Air Energy Recovery Ventilators	Aldes	Greenheck Ruskin Cook	

CONTRACTOR'S NAME:_____ DATE:_____

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
23 73 23	Custom Indoor Central Station-Air Handling Units	Engineered Air	Haakon Bousquet Daikin	
23 74 43	Packaged HVAC Rooftop	Trane	JCI	

1.2 LABOUR RATES

.1 The following labour rates shall apply for calculating the cost of credit or extras on Change Notices. The rates shall include any employee benefits. The labour rates do not include overhead and profit.

Superintendent $_____/hr

Journeymen $_____/hr

Labourers $_____/hr

Sheet Metal $_____/hr

Insulation $_____/hr

Other $_____/hr

1.3 HVAC TENDER PRICE (EXCLUDING HST)

.1 Having carefully examined all Drawings and Specifications and the Addenda to the Drawings and Specifications, and having carefully examined the sites and all conditions affecting the work, we, the undersigned thereby offer to provide all plant, labour, materials and incidentals required to complete the work of all trades for: All the work specified for herein for

the Total Stipulated Price of: $_____

_____

(in writing)

in lawful money of Canada; included in which are all applicable excise taxes, custom duties, freight, exchange, and all other charges. HST is not included.

CONTRACTOR'S NAME:_____ DATE:_____

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 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 TENDERS AND BONDING

.1 Complete Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of tender documents.

.2 Submit Supplemental Tender Form as noted.

.3 Submit tender based on specified described equipment or Alternates listed.

.4 State in Tender, names of all Subcontractors proposed for work under this Division.

.5 No bonding required for this Contractor.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 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 alloted 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.

1.9 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.

1.10 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.

1.11 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

1.12 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. $2,000.00)
- .2 Demolition
- .3 Specialty piping
- .4 Boilers
- .5 Circulation pumps
- .6 Heating piping
- .7 Piping insulation
- .8 Ductwork
- .9 Duct insulation
- .10 Grilles and diffusers
- .11 Fire stopping
- .12 Fans and equipment
- .13 HVAC unit
- .14 Indoor MUA unit
- .15 Fan Coil
- .16 Packaged V
- .17 HVAC system commissioning
- .18 VRF/heat pump equipment
- .19 Building automation systems
- .20 Testing, adjusting, and balancing
- .21 Refrigeration piping
- .22 HVAC contractor closeout requirements (min. of 3% for the first $500,000.00, 1% from $500,000.00 to $5,000.000.00, and 0.5% beyond. Shall not be less than $5,000.00.)

.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.

1.13 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.

1.14 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 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.

.8 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.

.9 Check work described by catalog data with Contract Documents for deviations and errors.

.10 Shop drawings and product data shall show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances. e.g., access door swing spaces.

.11 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.

.12 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.

.13 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 consultant’s 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.

1.15 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.

1.16 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 review and approval. Submission of individual data will not be accepted unless directed by Consultant. Submission can be done electronically in PDF format or as a hard copy.

.1 Electronic submission/PDF file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.

.2 Hard copy 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 and 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.

1.17 AS-BUILT DRAWINGS

.1 Site records:

.1 Contractor shall provide two (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 submittal for TAB and review:

.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" (Company Name) (Signature of Contractor) (date).

.3 TAB to be performed using as-built drawings.

.4 Submit copy to Consultant for review and approval. When returned, make corrections as directed.

.3 As-built drawings final submittal:

.1 Once approved, submit completed, reproducible paper as-built drawings as well as a scanned PDF file copy on USB stick with Operation and Maintenance Manuals. Once approved, submit completed, reproducible paper as-built drawings as well as a scan PDF of **each** drawing file on USB stick (note PDFs cannot be combined).

1.18 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 and Maintenance Manual.

.3 If HVAC sub-contractor with offices located more than 80 km (50 miles) from Project site is used, provide service/warranty work agreement for warranty period with local HVAC sub-contractor approved by Consultant. Include copy of service/warranty agreement in warranty section of Operation and Maintenance Manual.

.4 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.

.5 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.

1.19 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

1.20 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.

1.21 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.

1.22 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 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 Gas detection system commissioning (Refer to spec section 25 05 21 Part 3)

.3 Seismic Restraint Engineers' Letter.

.4 TSSA report for new boiler/pressure vessel installation or written confirmation from TSSA that they opted to not inspect the system. (Low pressure systems that have either a wetted heating surface of 30 sq ft (2.89 sq m) or less, or a power rating of 100 MBH (30 kW) or less are exempt.

.5 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.

.4 Test fuel oil systems to CSA B139 1976, CSA B139S1-1982 and 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	System Checklist
Boiler(s)	Boiler(s)
Chiller(s)	Chiller(s)
Rooftop Heating/Cooling Unit(s)	Humidifiers
Fan Coil Units	Air Handling Units
Exhaust Fans	Heat Recovery Unit(s)
Air Handling Unit(s)	Pumps
Heat Recovery Unit(s)	
Pumps	
Humidifiers	
Controllers/Valves/Dampers	
Relays/Sensors/Transducers	

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 Hydronic water systems

.4 Boilers and pumps

.5 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.

.4 All starters for HVAC equipment to be provided by this contractor. Wired by Electrical Division.

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 CONCRETE SLAB X-RAY/SCANNING

.1 This Contractor shall retain the services of a qualified company to provide an 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.

1.32 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.

1.1 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.

1.2 INTEGRATED LIFE SAFETY SYSTEMS TESTING

.1 HVAC systems in this building, including but not limited to smoke control dampers, smoke control fans, high speed low velocity ceiling fans, makeup air units, and heat tracing for fire protection systems may be subject to Integrated Life Safety Systems testing.

.2 The HVAC Contractor shall co-ordinate with the Integrated Life Safety Systems Testing Agent as follows:

.1 Confirm which HVAC systems are to be included as part of the testing process.

.2 Verify in writing to the Integrated Life Safety Systems Testing Agent that HVAC 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 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.

1.9 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

.1 This section is to read in conjunction with Division 1, the general condition, and the General Requirements of the mechanical trades.

1.2 REFERENCES

.1 Tested to ANSI/UL Standard 508.

.2 UL-508 certified for the building and assembly.

.3 CSA or C-UL stickers shall be applied to both the VFD and option panels.

.4 Manufacturers shall be ISO 9001 certified facilities.

1.3 SUBMITTALS

.1 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalogue information.

.2 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

.3 Harmonic filtering. The manufacturer shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will met the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer–utility interface or primary side of the main distribution transformer.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Danfoss Graham.

.2 ABB.

.3 AC Tech.

2.2 GENERAL

.1 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.

.2 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFD's utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

.3 Include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

.4 Provide DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFD's without DC link reactors shall provide a minimum 5% impedance line reactor.

.5 Full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

.6 Provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.

.7 An automatic energy optimization selection feature shall be provided in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.

.8 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

.9 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.

.10 Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFD's not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.

.11 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

.12 VFD's operating 600/3/60 motors not designed to meet Nema MG1 Part 31 should include Output dv/dt (LC) Reactors.

2.3 PROTECTIVE FEATURES

.1 VFD shall be provided with an integral disconnect and Integral Fast Blow Semi-Conductor fuses sized as specified by ULC. Fuses shall be Bussman JJS type or equivalent.

.2 A minimum of Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

.3 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes are not acceptable.

.4 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.

.5 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

.6 To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Motors shall have inverter rated insulation (1600V).

.7 VFD shall include a “signal loss detection” circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC and shall be programmable to react as desired in such an instance.

.8 VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.

.9 VFD shall catch a rotating motor operating forward or reverse up to full speed.

.10 VFD shall be rated for 100,000 amp interrupting capacity (AIC).

.11 VFD shall have externally mounted EMI electromagnetic suppressor to limit the EMI and RFI output from the VFD. VFD to be mounted in an all metal cabinet to limit radiated RFI.

.12 VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

.13 VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt VFD’s, and 701V AC on 575 volt VFD’s.

.14 For remote VFD installations, provide an output filter (load side reactor) at each VFD to protect the equipment motor. Coordinate installation with equipment manufacturer.

2.4 INTERFACE FEATURES

.1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.

.2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.

.3 The VFD shall provide digital manual speed control. Potentiometers are not acceptable.

.4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.

.5 The keypads for all sizes of VFD's shall be identical and interchangeable.

.6 To set up multiple VFD's, it shall be possible to upload all set-up parameters to the VFD's keypad, place that keypad on all other VFD's in turn and download the set-up parameters to each VFD. To facilitate setting up VFD's of various sizes, it shall be possible to download from the keypad only size independent parameters.

.7 Display shall be programmable to display in 9 languages including English, Spanish and French.

.8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

.9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

.10 A quick set-up menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.

.11 The VFD shall include a standard RS-485 communications port for connection to a Johnson Controls N2 and Siemens FLN serial communication system. The connection shall be software selectable and addressable by the user. The option for Lonworks and BacNet communication must also be available.

.12 As a minimum, the following points shall be controlled and/or accessible:

VFD Start/Stop, Speed reference, Fault diagnostics, and Meter points as follows:

Motor power in HP, Motor power in kW, Motor kW-hr, Motor current, Motor voltage, Hours run, Feedback signal #1, Feedback signal #2, DC link voltage, Thermal load on motor, and Thermal load on VFD, Heat sink temperature.

.13 Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.

.14 Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

.15 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

.16 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFD's unable to show these four displays simultaneously shall provide panel meters.

.17 Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.

.18 The sleep mode shall be functional in both follower mode and PID mode.

.19 Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.

.20 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

.21 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature (oF) for a cooling tower application.

.22 VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.

.23 If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.

.24 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.

.25 The VFD shall store in memory the last 10 faults and related operational data.

.26 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

.27 Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.

.28 Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.

.29 Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.

.30 Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

.31 A contact/relay shall be provided to shut the fans down upon fire alarm signal.

2.5 ADJUSTMENTS

.1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.

.2 Sixteen preset speeds shall be provided.

.3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.

.4 Four current limit settings shall be provided.

.5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: under-voltage, over-voltage, current limit and inverter overload.

.6 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

.7 An automatic “on delay” may be selected from 0 to 120 seconds.

2.6 SERVICE CONDITIONS

.1 Unit shall operate in ambient temperature of -10°C to 40°C (14°F to 104°F).

.2 Unit shall operate in 0 to 95% relative humidity, non-condensing.

.3 Operate in elevation up to 3,300 feet without derating.

.4 Maximum AC line voltage variation, -10 to +10% of nominal with full output.

.5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

2.7 FACTORY TESTING

.1 To ensure quality and minimize infantile failures at the jobsite, the manufacturer shall test the complete VFD. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.

.2 All optional features shall be functionally tested at the factory for proper operation.

2.8 BYPASS SWITCH

.1 Bypass Controller - Automatic transfer to line power via contactors. When in the “Drive” mode, the bypass contactor is open and the drive output contactor is closed. In the “Bypass” position, the drive output contactor is open, and the bypass contactor is closed via Start/stop command. Start/stop via customer supplied maintained contact shall be Dry type 115V compatible and shall function in both the “Drive” and “Bypass” modes. The design shall include single-phase protection in both the VFD and bypass modes.

Part 3 Execution

3.1 START-UP SERVICE

.1 The manufacturer shall provide start-up and commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

3.2 EXAMINATION

.1 Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

3.3 INSTALLATION

.1 Install to manufacturer’s recommendations.

.2 Install to the requirements of the local Hydro codes. Obtain hydro permits and pay all fees.

.3 Install in an accessible location and proper service height from floor.

.4 Install in clean, dry, and conditioned environment.

.5 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

.6 Wiring of devices to be to the standards of Electrical Division.

.7 Provide one manufacturer of VFD’s throughout the project.

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 The VFD shall be warranted by the manufacturer for a period of five (5) years from date of Ready for Takeover. The warranty shall include parts, labour, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ANSI/ASME B40.100, Pressure Gauges and Gauge Attachments.

.3 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

.4 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Submit manufacturer's product data for following items:

- .1 Thermometers.
- .2 Pressure gauges.
- .3 Stop cocks.
- .4 Siphons.
- .5 Wells.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid point of scale or range.

.2 Ranges: suitable for application.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, liquid filled, 225 mm (9") scale length: to CAN/CGSB 14.4.

- .1 Acceptable Manufacturers:
  - .1 Trerice
  - .2 Winters 91T
  - .3 Wiess

2.3 REMOTE READING THERMOMETERS

.1 100 mm (4") diameter liquid filled activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless steel case for wall mounting.

- .1 Acceptable Manufacturers:
  - .1 Trerice
  - .2 Winters Contractor

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

.1 115 mm (4 1/2"), dial type: to ANSI/ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.1 Acceptable Manufacturers:

.1 Trerice

.2 Winters

.3 Wiess

.2 Provide:

.1 Siphon for steam service.

.2 Snubber for pulsating operation.

.3 Diaphragm assembly for corrosive service.

.4 Gasketted pressure relief back with solid front.

.5 Bronze stop cock.

Part 3 Execution

3.1 GENERAL

.1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

.1 Install in wells on all piping. Provide heat conductive material inside well.

.2 Install in locations as indicated and on inlet and outlet of:

.1 Heat exchangers.

.2 Water heating and cooling coils.

.3 Water Boilers

.4 Chillers.

.5 Cooling towers.

.6 Boiler Room HWS and HWR.

.7 In other locations indicated.

.3 Install wells as indicated only for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Upstream and downstream of control valves.

.4 Inlet and outlet of coils.

.5 Inlet and outlet of liquid side of heat exchangers.

.6 Outlet of boilers.

.7 In other locations as indicated.

.2 Install gauge cocks for balancing purposes, elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

.1 Install engraved lamicoid nameplates as specified elsewhere identifying medium.

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 BELLOWS TYPE EXPANSION JOINTS

.1 For axial, lateral or angular movements, as indicated.

.2 Maximum operating pressure: 1034 kPa (150 psi).

.3 Maximum operating temperature: 200°C (392°F).

.4 Type A: Free flexing, factory tested to 1½ times maximum working pressure. Furnish test certificates.

.5 Type B: Externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1.5 times maximum working pressure. Furnish test certificates.

.6 Bellows:

.1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

.7 Reinforcing or control rings:

.1 2 piece nickel iron.

.8 Ends:

.1 Slip-on flanges to match pipe.

.9 Liner:

.1 Austenitic stainless steel in direction of flow.

.10 Shroud:

.1 Carbon steel, painted.

2.6 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.

2.7 FLEXIBLE CONNECTIONS (METAL)

.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.

2.8 FLEXIBLE SPHERICAL EXPANSION JOINT (EPDM)

.1 Application: To suit motion.

.2 Minimum length in accordance with manufacturer's recommendations to suit required offset / application.

.3 Construction:

.1 Peroxide cured EPDM cover and liner and Kevlar reinforced tire cord fractioning.

.2 Solid steel rings within raised face rubber flange ends to prevent pullout.

.3 Ductile iron external ring between spheres.

.4 Ductile iron or steel flanges.

.4 Provide control rods on all unanchored piping assemblies, on all spring mounted equipment connections, or when necessary to meet system pressure and temperature ratings.

.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.

2.9 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

2.10 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

2.11 FLOATING RISER SYSTEM COMPONENTS

.1 Free Standing Spring Isolator

.1 Vibration isolators shall be free standing, unhoused, laterally stabile steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed to provide a minimum 50% overload capacity.

.2 Springs shall be assembled or welded between top and bottom load plates. The upper load plate shall be provided with steel leveling bolts, lock nut and washer for attachment to the supported equipment. The lower load plate shall incorporate a non-skid noise isolation pad and shall have provisions for bolting the isolator to the supporting structure, as required.

.3 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as otherwise indicated on the project documents. Springs shall be colour coded or otherwise identified to indicate load capacity.

.4 Design Basis: Kinetics Noise Control, Model FDS.

.2 Coil Spring Isolator Incorporated with a Steel Housing

.1 Spring isolators shall be seismic control restrained spring isolators, incorporating a single vibration isolator, having all the characteristics of the free-standing open spring isolators as previously specified. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation of the spring during normal equipment operating conditions.

.2 Vibration isolators shall incorporate a steel housing and snubbing grommet system designed to limit motion to approximately 0.2" (5 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed housing. The restraining system shall be designed to withstand a force equivalent to 1.0 g in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, an adapter plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation spring, the load path will include a minimum 0.25" (6 mm) thick neoprene pad.

.3 To facilitate servicing, the isolator will be designed in such a way that it can be removed without the requirement to lift or otherwise disturb the supported equipment.

.4 Design Basis: Kinetics FHS and FHSL.

.3 Seismic Control Restrained Spring Isolator

.1 Vibration isolators shall be seismically rated, restrained spring isolators for equipment which is subject to load variations and large external forces. Isolators shall consist of large diameter, laterally stable, steel springs assembled into welded steel housing assemblies designed to limit movement of the supported equipment in all directions.

.2 Housing assembly shall be of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom plate with internal non-skid noise isolation pads and holes for anchoring of housing to supporting structure. Housing shall be hot dip galvanized for corrosion resistance. Housing shall be designed to provide a constant free and operating height within 1/8" (3 mm).

.3 The isolator housing shall provide a minimum of 1 g restraint in all directions.

.4 Spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Springs shall be colour coded or otherwise identified.

.5 Spring elements shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be polyester powder coated and shall have a 1000 hr rating when tested in accordance with ASTM B-117.

.6 Design Basis: Kinetics FLSS.

.4 All Direction 3 Axis Riser Anchor Assembly

.1 Risers shall be restrained against excessive movement during service by the use of 3-axis resilient anchors designed to withstand the required installation and operating forces. Anchors are intended to be used in sets of two (2) and be oriented to effectively restrain the riser in all three directions, with particular emphasis on large and variable vertical loads that would be imparted by changes in the riser weight.

.2 Anchors shall be of steel construction and shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical riser movement at each anchor location to a maximum of ¼" (6 mm) in any direction.

.3 Anchors shall include a minimum 1/2" (13 mm) thick resilient neoprene pad to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Anchors shall be capable of withstanding an externally applied force of up to their rated capacity in any direction.

.4 Design Basis: Kinetics KPA.

.5 Horizontal Motion Limiting Riser Guide Assembly

.1 Risers shall be restrained against excessive lateral movement during service by the use of 2-axis resilient guides designed to withstand the required installation and operating forces. Guides are intended to be used in sets of two (2) and be oriented to effectively restrain the riser in all horizontal directions, but to allow free motion within their operating range in the vertical axis.

.2 Guides shall be of steel construction and shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design loads. Guides shall limit lateral riser movement at each Guide location to a maximum of ¼" (6 mm) in any direction.

.3 Anchors shall include a minimum 1/2" (13 mm) thick resilient neoprene pad to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Anchors shall be capable of withstanding an externally applied lateral force of up to their rated capacity in any direction.

.4 Design Basis: Kinetics KRG.

.6 Spring Isolation Hanger

.1 Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding 0.4" (10 mm), shall be hangers consisting of a free-standing, laterally stabile steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket.

.2 The bracket shall be finished with a polyester powder coating.

.3 The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.

.4 The 1" and 2" hanger brackets shall incorporate spring caps with indexed steps which correspond to the washer diameter of appropriately sized hanger rod to keep the rod centered in the spring cap and reduce rod misalignment.

.5 Springs shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.

.6 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as indicated on the project documents. Springs shall be colour coded or otherwise identified to indicate load capacity.

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.

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 heating 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 <u>not</u> 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.

.9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-69.

.10 U-bolts: carbon steel to MSS SP-58 with 2 nuts at each end to ASTM A 563.

.1 Finishes for steel pipework: black

.2 Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-58.

2.3 RISER CLAMPS

.1 Steel or cast iron pipe: black carbon steel to MSS-SP-58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS-SP-58, type 42.

.3 Bolts: to ASTM A 307.

.4 Nuts: to ASTM A 563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m² (13.12 lbs/ft²) 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.

2.5 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.

2.6 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 15 mm (1/2") minimum, 50 mm (2") maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm (2"): use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger to be complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: 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.

2.7 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.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 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.

2.10 OTHER EQUIPMENT SUPPORTS

.1 From structural grade steel meeting requirements of structural steel section specified herein.

.2 Submit structural calculations with shop drawings.

2.11 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.

.6 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 15 mm (1/2") or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.7 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25% of total load.

3.2 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 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.6 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')	

.7 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 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.

.5 CSA B272-93 – Prefabricated Self-Sealing Roof Vent Flashings

.6 CRCA (Canadian Roofing Contractor’s Association)

.7 SPRI (Single Ply Roofing Institute)

.8 CUFCA (Canadian Urethane Foam Contractor’s Association) and CGSB-51-GP-46MP, Manual for “Installers of Spray Polyurethane Foam Thermal Insulation”

.9 CSA G40.21-M1987, M350W, and M300W (Structural Quality Steels)

.10 CSA W47.1-1983 (Certificate of Companies for Fusion Welding of Structural Steel)

.11 CSA W59-M1989 (Welded Steel Construction – Metal Arc Welding)

.12 CSA G164-M1981 (Hot Dip Galvanizing of Irregularly Shaped Articles)

1.2 RELATED SECTIONS

.1 Section 03300 – Cast-in-place Concrete

.2 Section 05210 – Steel Joists

.3 Section 05300 – Metal Deck

.4 Section 06100 – Rough Carpentry

.5 Section 07200 – Thermal Protection

.6 Section 07500 – Membrane Roofing

.7 Section 07900 – Joint Sealers

1.3 DESIGN REQUIREMENTS

.1 Construct support systems 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 Design 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.

.4 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP-58.

1.4 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.

.3 Manufacturer’s installation instruction.

1.5 MAINTENANCE DATA

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

1.6 QUALITY ASSURANCE

.1 Roof accessories manufactures to have minimum five (5) years documented experience in the design and fabrication of roofing specialties and accessories.

1.7 SPECIAL WARRANTY

.1 Warrant products installed under this section of work to be free of leaks, condensation, and defects in materials and/or manufacture for a period of twenty (20) years when installed in accordance with the manufacturer’s written instructions.

Part 2 Products

2.1 PIPE/SUPPORT

.1 Pipe/Support:

.1 Adjustable height 6061-T6, hollow aluminum with mill finish, urethane insulated supports, 2" (51 mm) diameter.

.2 Stack Jack Flashing:

.1 Height to suit application.

.2 Fully urethane insulated.

.3 Aluminum construction.

.4 Complete with EPDM triple pressure grommet seal and EPDM base seal and other accessories as required to suit roof type.

.3 Provide appropriate stainless steel mounting hardware to suit supported pipe/equipment.

.4 Provide appropriate system support as specified in this section to suit application.

.1 Single Plain Pipe: Type 304 stainless steel pipe roller assembly to suite actual 0.D pipe.

.2 Double Plain Pipe: Type 304 stainless steel pipe roller assemblies sized to suit actual 0.D pipe.

.3 Single Insulated Pipe: Type 304 stainless steel pipe cradle assembly sized to suit actual 0.D of insulated pipe.

.4 Double insulated Pipe: Type 304 stainless steel pipe cradle assemblies sized to suit actual 0.D of insulated pipe.

.5 Acceptable Manufacturers:

.1 Thaler MERS 600 series.

.2 Acceptable equals if submitted and approved during tender period.

2.2 DUCT SUPPORT

.1 Duct support:

.1 Adjustable height 6061-T6, hollow aluminum with mill finish, urethane insulated supports, 2" (51 mm) diameter.

.2 Stack Jack Flashing:

.1 Height to suit application.

.2 Fully urethane insulated.

.3 Aluminum construction.

.4 Complete with EPDM triple pressure grommet seal and EPDM base seal and other accessories as required to suit roof type.

.3 Provide appropriate stainless steel mounting hardware to suit application.

.4 Cross-bar carrier assembly of length to suit application with EPDM end caps.

.5 Acceptable Manufacturers:

.1 Thaler MERS-800 series.

.2 Acceptable equals if submitted and approved during tender period.

2.3 ROOFED IN EQUIPMENT SUPPORT (SMALL UNITS)

.1 Equipment supports:

.1 Adjustable height 6061-T6, hollow aluminum with mill finish, urethane insulated supports, 2" (51 mm) diameter.

.2 Stack Jack Flashing:

.1 Height to suit application.

.2 Fully urethane insulated.

.3 Aluminum construction.

.4 Complete with EPDM triple pressure grommet seal and EPDM base seal and other accessories as required to suit roof type.

.3 Provide appropriate stainless steel mounting hardware to suit application.

.4 Cross-bar carrier of length to suit application with EPDM end caps, anti-vibration pads and 1 1/2" (38 mm) diameter pipe section reinforcing ties.

.5 Acceptable Manufacturers:

.1 Thaler MERS-900 series.

.2 Acceptable equals if submitted and approved during tender period.

2.4 NON-PENETRATING ROOF EQUIPMENT SUPPORT (SMALL UNITS)

.1 Provide zero penetration support on roof where indicated.

.2 Supports shall be ballasted to resist wind loads.

.3 Ballast system shall be fully engineered by manufacturer to withstand:

.1 Unit weight

.2 Wind loads based on prevailing wind conditions on roof of building.

.4 Engineered shop drawings, stamped by a Professional Engineer shall be provided indicating loading and calculations that demonstrate that the stand is suitable for the proposed application.

.5 Base shall be made of non-combustible material.

.6 Frames shall be galvanized. All fastenings, rods, nuts, washers, etc. shall be stainless steel.

.7 Provide shop drawings as specified. Install to manufacturers recommendations.

.8 Acceptable Manufacturers:

.1 Portable pipe hanger

.2 Bigfoot systems

.3 Miro rooftop support

.4 Trikon Systems

.5 Walravin BIS Yet

.6 Ecofoot

2.5 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.6 ROOF CURB MOUNTED EQUIPMENT

.1 Install as per manufacturer's instructions on roof curbs provided by manufacturer as indicated.

.2 Provide all necessary continuous pressure treated wood blocking and 24 gauge metal liner on all exposed wood as required to install roof curb level.

2.7 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

2.8 PIPING THROUGH ROOF

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

2.9 ROOF MOUNTED PIPE SUPPORT

.1 Provide zero penetration pipe support on roof where indicated.

.2 Base shall be made of high density polypropylene with UV protection. Maximum loading shall be 50 lb/sq.ft.

.3 Frames shall be galvanized. All fastenings, rods, nuts, washers, hangers, etc. shall be stainless steel.

.4 Provide shop drawings as specified. Install to manufacturers recommendations.

.5 Acceptable Manufacturers:

.1 Portable pipe hanger

.2 Bigfoot systems

.3 Miro rooftop supports

.4 Walravin BIS Yeti

.5 Ecofoot

Part 3 Execution

3.1 INSTALLATION

.1 Roof support install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Provide protection against deterioration due to contact of dissimilar metals.

.2 Flashing Installation:

.1 Install roof support flashing in accordance with manufacturer's printed instructions.

.3 Vibration Control Devices:

.1 Install as indicated and at all roof mounted equipment that is not internally isolated.

.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 PIPE SUPPORT SPACING

.1 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')	

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

.3 Gas and fuel oil piping: every 1.8 m (6').

3.3 EXAMINATION

.1 Report to the contractor in writing, defects of work prepared by other trades and other unsatisfactory site conditions. Verify site dimensions. Commencement of work will imply acceptance of prepared work.

3.4 ADJUSTING

.1 Verify that all manufactured units have been installed in accordance with specifications and details and will function as intended. Adjust any items where necessary to ensure proper operation.

3.5 CLEANING

.1 Clean manufactured units using materials and methods approved by manufacturer. Do not use cleaning techniques which could impair performance of the roofing system.

END OF SECTION

Part 1 General

1.1 APPLICATION

.1 Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.

.2 Where the structural engineer or architect documents have Ie*Sa(0.2)*Fa<3.5 seismic is not required on the plumbing, HVAC, electrical, or fire protection systems.

.3 Where the structural engineer or architect documents have Ie*Sa(0.2)*Fa≥3.5 seismic is required on the plumbing, HVAC, electrical, or fire protection systems.

.4 Seismic will always be required on fire protection systems when required by NFPA codes.

.5 Seismic will always be required on any “Disaster Relief Building.” For example, hospitals, police stations, ambulance building, etc.

.6 When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

1.2 SECTION INCLUDES

.1 Seismic Requirements for single rod hanger support for conduit, pipe and other similar systems.

.2 Seismic Requirements for trapeze type supports for cable tray, conduit, pipe and other similar systems.

.3 Seismic requirements for all equipment and piping.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Vibration Isolation Measures.

1.4 REFERENCE STANDARDS

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 National Building Code of Canada (NBC).

.3 Canadian Standards Association

.1 CSA S832, Seismic Risk Reduction of Operation and Functional Components (OFCs) of Buildings.

.2 CAN/CSA-S16.1 Limit States Design of Steel Structures

.3 CAN3-S136 Design of Cold Steel Structural Members

.4 CSA W47.1 Certification of Companies for Fusion Welding of Steel

.5 CSA W59 Welded Steel Construction

.4 SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems

.5 Canadian Institute of Steel Construction

.6 Canadian General Standards Board

.7 Underwriter Laboratories of Canada

.8 Workers Compensation Board of BC

.9 American Society of Testing and Materials

.1 ASTM A653/S653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (galvannealed) by the Hot Dip Process.

.2 ASTM A879M Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.

.3 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.4 ASTM A325M Specification for Structural Bolts, Heat Treated 830MPa Minimum Tensile Strength.

.10 All local codes.

.11 NFPA-13: Installation of Fire Sprinkler Systems.

.12 FEMA: Federal Emergency Management Activity.

.13 FEMA: Seismic Restraint Installation Manuals 412. 413 and 414

.1 FEMA 412: Installing Seismic Restraints for Mechanical Equipment

.2 FEMA 413: Installing Seismic Restraints for Electrical Equipment

.3 FEMA 414: Installing Seismic Restraints for Duct and Pipe

.14 ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.).

.15 ASHRAE Applications Handbook; Seismic and Wind Restraint Design Chapter.

1.5 DEFINITIONS

.1 A_v: Effective peak velocity related acceleration coefficient BOCA, SBC Code.

.2 S_1: Mapped Long Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.

.3 S_s: Mapped Short Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.

.4 v: Zonal Velocity Coefficient NBC-Canada.

.5 VISCMA: The Vibration Isolation and Seismic Control Manufacturers Association has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.

.6 VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.

.7 Z: Seismic Zone defines Seismic Coefficient C_a used by UBC Code.

1.6 PERFORMANCE REQUIREMENTS

.1 Design Ground Acceleration Coefficient (A_v, S_s, v, or Z depending on Code = X.XX).

.2 (If IBC or TI-809-04) Design Long Period Ground Acceleration Coefficient (S_1 = X.XX).

.3 Design Soil Type = (S_a, S_b, S_c, S_d) as appropriate. (If NBC Canada, the Foundation Factor).

.4 Importance or Performance Factor appropriate to structure = I_p = X.XX.

.5 If UBC Zone 4, Proximity to Fault and, if less than 10km, Fault Type.

.6 Schedule or drawings indicating critical (Ip = 1.5) Duct/Piping systems, including systems whose importance factor may be increased by proximity to critical components.

1.7 DESCRIPTON OF SYSTEM

.1 It shall be understood that the requirements of this seismic restraint section are in addition to other requirements as specified elsewhere for the support and attachment of equipment and HVAC services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section.

.2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.

.3 All seismic snubber restraint assemblies shall meet the following minimum requirements:

.1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).

.2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.

.3 All snubbers are to include a maximum air gap of 0.25 in (6 mm).

.4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.

.5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:

.1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.

.2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.

.3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

1.8 SYSTEM DESIGN

.1 Seismic restraint manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

.2 The contractor shall furnish, to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length, and width dimensions, and installed operating weights of the equipment to be restrained.

.3 All piping, ductwork and equipment is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as “worst case” reaction loads for each restraint and/or anchor size.

.4 The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size or the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

1.9 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS

.1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.

.2 Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

.3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.

.4 All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 3.01.

.5 Friction from gravity loads shall not be considered resistance to seismic forces.

.6 Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14. Sway bracing used for seismic restraint purposes must be fitted with provisions to resist the vertical force component of the diagonal brace. Single diagonal brace for seismic restraint will not be approved.

1.10 ALTERNATE SYSTEMS

.1 Provisions of the General Conditions and Supplemental Conditions of the specifications shall govern the use of alternate systems to those specified.

.2 Manufacturers not listed as approved in “Part 2 Materials” of this section must secure approval to bid a minimum of ten (10) days prior to the project bid date.

.3 Uncertified internal equipment seismic restraint systems are disallowed for use on this project.

1.11 QUALITY ASSURANCE

.1 The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.

.2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.

.3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

.4 Only companies experienced in performing the work of this section shall do the installation.

.5 All seismic restraint installations shall be independently reviewed by the Owners Representative for compliance with project specifications.

1.12 SUBMITTALS

.1 Product Data: Include Seismic Rating Curve for each seismically rated isolator or restraint component.

.2 Samples: The contractor shall submit samples of specified seismic snubber devices for approval.

.3 Shop Drawings shall include the following:

.1 Design Calculations: Calculate requirements for selecting seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years of experience in the design of seismic restraints. Professional engineer shall have local jurisdiction and provide periodic field review and final certification upon completion of the project. All costs and fees associated with the engineering shall be the responsibility of this contractor.

.2 Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.

.3 Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.

.4 Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in “Performance Requirements” Article above. Include the following:

.1 Basis for Certification: Indicate whether the “withstand” certification is based on actual test assembled components or on calculations.

.2 Indicate the equipment is certified to be durable enough to:

.1 structurally resist the design forces and/or

.2 will remain functional after the seismic event.

.5 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

.6 Detailed description of the assumed equipment anchorage devices on which the certification is based.

1.13 DELIVERY, STORAGE, AND HANDLING

.1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.

.2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

1.14 WORK FURNISHED BUT NOT INSTALLED

.1 The materials and systems specified in this section shall be purchased by the HVAC contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

.2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the seismic services.

1.15 COORDINATION

.1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.

.2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. roof curbs, cooling towers, and other similar equipment).

1.16 INSTALLATION

.1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

Part 2 Products

2.1 MATERIALS

.1 Unless otherwise specified materials used in the Work shall conform to the following:

.1 All steel rolled sections and steel plates shall conform to CAN/CSA G40.21M-300W

.2 All steel hollow structural steel sections shall conform to CAN/CSA G40.21-350W Class C

.3 Structural steel bolts, nuts and washers shall conform to ASTM A325M

.4 Weld electrodes shall be SMAW-E-E480XX and SAW-F480-EXXX.

2.2 ACCEPTABLE MANUFACTURERS

.1 All seismic snubbers and combination restraint/vibration isolation materials specified herein shall be provided by a single manufacturer to assure sole source responsibility for the proper performance of the materials used. Manufacturer is to be a member of VISCMA.

.2 Anchor types and sizes are to be per the design data as provided by the seismic restraint manufacturer.

.3 Materials and systems specified herein and detailed or scheduled on the drawings are based upon materials manufactured by Kinetics Noise Control Inc. Materials and systems provided by other manufacturers are acceptable, provided that they meet all requirements as listed in this specification.

.4 Kinetics Noise Control Inc.

.5 Cooper 'B' Line.

.6 Unistrut Building Systems.

.7 Mason Industries.

2.3 SEISMIC SNUBBER TYPES

.1 GENERAL

(Isolator/Snubber Types contained herein are per ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, HVAC Applications, Seismic and Wind Restraint Design)

.1 Type A, Coil Spring Isolator Incorporated Within a Ductile Iron or Cast Aluminum Housing.

.1 Cast iron or aluminum housings are brittle when subjected to shock loading and are therefore not approved for seismic restraint applications.

.2 Type B, Coil Spring Isolator Incorporated Within A Steel Housing

.1 Spring isolators shall be seismic control restrained spring isolators, incorporating a single or multiple coil spring element, having all of the characteristics of free standing coil spring isolators as specified in the vibration isolation portion of this specification. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.

.2 Vibration isolators shall incorporate a steel housing and neoprene snubbing grommet system designed to limit motion to no more than ¼" (6 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing. The restraining system shall be designed to withstand the seismic design forces in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, a steel adapter base plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation coil spring, the load path will include a minimum ¼" (6 mm) thick neoprene pad.

.3 Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.

.4 To facilitate servicing, the isolator will be designed in such a way that the coil spring element can be removed without the requirements to lift or otherwise disturb the supported equipment.

.5 Spring isolators shall be Model FHS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (2).

.3 Type C, Coil Spring Isolator Incorporated Within a Steel Housing

.1 Spring isolators shall be seismic control restrained spring isolators, incorporating one or more coil spring elements, having all the characteristics of free standing coil spring isolators per the vibration isolation section of this specification, for equipment which is subject to load variations and/or large external forces. Isolators shall consist of one or more laterally stable steel coil springs assembled into fabricated welded steel housings designed to limit movement of the supported equipment in all directions.

.2 Housing assembly shall be made of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom load plate with internal non-skid isolation pads and holes for anchoring the housing to the supporting structure. Housing shall be hot dipped galvanized for outdoor corrosion resistance. Housing shall be designed to provide a constant free and operating height within ⅛" (3 mm).

.3 The isolator housing shall be designed to withstand the project design seismic forces in all directions.

.4 Coil spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.

.5 Spring isolators shall be Model FLS and FLSS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (3).

.4 Type D, Coil Spring Isolator Incorporated with Integral Seismic Restraint

.1 Spring isolators shall be single or multiple coil spring elements which have all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of this specification, incorporating lateral and vertically restrained seismic housing assemblies. Spring elements shall be readily replaceable without the need to list or remove the supported equipment.

.2 Restraint housing shall be sized to meet or exceed the force requirements of the application and shall have the capability of accepting coil springs of various sizes, capabilities, and deflections as required to meet the required isolation criteria. All spring forces shall be contained within the coil/housing assembly, and the restraint anchoring hardware shall not be exposed to spring generated forces under conditions of no seismic force. Spring element leveling adjustment shall be accessible from above and suitable for use with a conventional pneumatic or electric impact wrench.

.3 Restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. Elastomeric elements shall be replaceable. Restraint shall allow ¼" (6 mm) free motion in any direction from the neutral position. Restraint shall have an overturning factor (ratio of effective lateral snubber height to short axis anchor spacing) of 0.33 or less to ensure optimum anchorage capacity.

.4 Spring isolators shall be Model FMS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (4).

.5 Type E, All Direction Neoprene Isolator

.1 Vibration Isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated cast-in-place top steel load transfer plate for bolting to equipment and a steel base plate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading.

.2 Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact.

.3 Isolator shall have minimum operating static deflections as shown on the project Vibration Isolation Schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.

.4 Neoprene isolators shall be Model RQ as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections .2.01, 2.02 and 2.03 (5).

.6 Type F, Light Capacity All Direction 3-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.

.2 Snubbers shall be of interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.

.3 Snubbers shall include a minimum ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Snubber shall be capable of withstanding an externally applied seismic force of up to 3,000 pounds (1360 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

.4 Three-axis seismic snubbers shall be Model HS-5 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and 2.01, 2.02, and 2.03 (6).

.7 Type G, Lateral 2-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive lateral movement during a seismic event by the use of 2-axis horizontal resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all horizontal directions, and additional snubbers shall be used as required by seismic design conditions.

.2 Snubbers shall be interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location to a maximum of ¼" (6 mm).

.3 Snubbers shall include a minimum of ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

.4 Two-axis lateral seismic snubbers shall be Model HS-2 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (7).

.8 Type H, Heavy Capacity All Direction 3-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive vertical and horizontal movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.

.2 Snubbers shall be of welded interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.

.3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be capable of withstanding an externally applied seismic force up to 10,000 pounds (4,540 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

.4 Three-axis seismic snubbers shall be Model HS-7 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (8).

.9 Type I, Horizontal 1-Axis External Seismic Snubber Assembly

.1 Equipment shall be restrained against excessive horizontal one-axis movement during a seismic event by the use of single-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.

.2 Snubbers shall be of steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location in the direction of impact to a maximum of ¼" (6 mm).

.3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to eliminate any contact during normal equipment operation.

.4 Single-axis seismic snubbers shall be Model HS-1 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (9).

.10 Type J, Cable Restraints for Suspended Piping and Ductwork

.1 Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for piping, ductwork, and suspended equipment in all lateral directions.

.2 Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.

.3 Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is lesser.

.4 Seismic wire rope connections shall be made using overlap wire rope “U” clips or seismically rated tool-less wedge insert lock connectors.

.5 Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical “up” forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable straps. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.

.6 Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.

.7 Seismic cable shall be as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.03 through 1.07 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.8 Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU, or KSCC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.9 Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.10 Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.11 Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

.12 Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

2.4 SEISMIC BRACING COMPONENTS

.1 Steel strut shall be 1-5/8 wide in varying heights and mig-welded combinations as required to meet load capacities and designs. A material heat code, part number, and manufacturer's name shall be stamped on all strut and fittings to maintain traceability to material test reports.

.2 Material for epoxy painted strut: ASTM A1011, SS, Grade 33.

.3 Material for pre-galvanized strut: ASTM A653, SS, Grade 33.

.4 Material for hot-dip galvanized strut: ASTM A1011, SS, Grade 33 and hot-dip galvanized after fabrication in accordance with ASTM A123.

.5 Material for fittings and accessories: ASTM A907, Grade 33, Structural Quality or ASTM A1011, SS, Grade 33.

.6 Fittings and accessories: Products shall be of the same manufacturer as strut and designed for use with that product.

2.5 UNIFORM BUILDING CODE REQUIREMENTS

.1 Seismic Zone Factor to Table 16-I for area of jurisdiction.

.2 Soil Profile Type to Table 16-J for area of jurisdiction.

.3 Seismic Importance Factor to Table 16-K for area of jurisdiction.

.4 Component Amplification Factor to Table 16-O for area of jurisdiction.

.5 Component Response Mod. Factor to Table 16-O for area of jurisdiction.

.6 Seismic Coefficient to Table 16-Q for area of jurisdiction.

.7 The total height of the structure (h_r) and the height of the system to be restrained within the structure (h_x) shall be determined in co-ordination with architectural plans and the General Contractor.

.8 Forces shall be calculated for individual supports using the above information. Exceptions to Table 16-O may be utilized. However, all use of exceptions shall be noted on submitted seismic bracing plan documents.

Part 3 Execution

3.1 GENERAL INSTALLATION

.1 Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.

.2 Refer to FEMA Manuals 412, 413, and 414 for typical industry standard installation guidelines.

.3 Upon completion of installation of all seismic restraint materials and before start-up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers/restraints.

.4 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.

.5 All seismic restraint systems shall be installed in strict accordance with the manufacturer's seismic restraint guidelines manual and all certified submittal data.

.6 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

.7 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

.8 Seismic restraints shall be attached to the structural system. Looping restraints around the system is not acceptable.

.9 Do not brace a system to two independent structures such as ceiling and wall.

.10 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

.11 Seismic restraint cables shall be adjusted such that they are not visibly slack, or the flexibility is approximately 25mm under thumb pressure for a 1500mm cable length (equivalent ratio for other cable lengths).

.12 All seismic restraint cables shall be at least 25mm clear of all other equipment and services.

3.2 EQUIPMENT INSTALLATION

.1 All external utility connections to restrained equipment shall be designed to allow differential seismic motion without damage to the equipment or utility connections.

.2 Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

.3 After equipment installation is completed, adjust limit stops following manufacturer's written instructions so that they are out of contact during normal operation.

.4 Adjust snubbers according to manufacturer's written instructions.

.5 Installation of seismic restraints shall not cause any change in position of equipment, resulting in stresses or misalignment.

.6 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration isolation system specified.

.7 Do not install any seismic restraint for equipment, cable trays or conduit that compromises isolation specified.

3.3 PIPING INSTALLATION

.1 Hold down clamps must be used to attach pipe to all trapeze members before applying restraints.

.2 Branch lines may not be used to restrain main lines.

.3 Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.

.4 Attach piping to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.

3.4 FASTENING TO STRUCTURE

.1 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

.2 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

.3 Coring is not permitted for the installation of concrete anchors. Use ground penetrating radar or equivalent method of embedment item detection to locate all embed items including reinforcing steel and electrical conduits. Concrete reinforcing steel and electrical conduits shall not be cut or damaged under any circumstances.

.4 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.

.5 If mounting hole diameter exceeds bolt diameter by more than 0.125" (3 mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.

.6 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.

3.5 INSPECTION

.1 The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.

.2 Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.

.3 The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.6 PIPING

.1 Seismically restrain all piping listed below. Use Type J Cable Restraints for all piping supported by vibration isolation hanger assemblies, including:

.1 Natural gas piping, medical gas piping, vacuum piping, petroleum based liquid piping, and compressed air piping equal to or greater than 1" (25 mm) in inside diameter.

.2 Brace remainder of piping to code requirements (IBC or TI-809-04) on in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

3.7 DUCTWORK

.1 Seismically restrain all ductwork listed below. Use Type J Cable Restraints for all ductwork supported by vibration isolation hanger assemblies, including:

.1 All rectangular and oval ducts with cross sectional area equal to or greater than 6 sq. ft. (0.55 sq. meters).

.2 All round ducts with diameters equal to or greater than 32" (812 mm).

.3 Brace remaining ductwork to code requirements (IBC or TI-809-04) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) “Seismic Restraint Manual Guidelines for Mechanical Systems”, Second Edition (Remaining Codes).

3.8 CONDUIT

.1 Seismically restrain all electrical conduit listed below. Use Type J Cable Restraints for all conduit supported by vibration isolation hanger assemblies, including:

.1 All round ducts with diameters equal to or greater than 32" (812 mm).

.2 Brace all conduit to code requirements (IBC or TI-809-04) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) “Seismic Restraint Manual Guidelines for Mechanical Systems”, Second Edition (Remaining Codes).

3.9 FIRE PROTECTION PIPING

.1 Fire protection, sprinkler piping, and related equipment is considered as “Life Safety Equipment” and is to be seismically restrained per guidelines as published by NFPA (National Fire Protection Association).

3.10 ROOF MOUNTED EQUIPMENT

.1 Provide seismic restraint for all isolated and non-isolated roof curbs and associated equipment.

.2 Provide seismically restrained steel coil spring isolation systems where isolation curbs are indicated and non-isolated seismic restraints for all other roof curb systems.”

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ASHRAE Handbook (2013) – Noise and Vibration Control chapter.

1.2 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.

.3 Provide detailed engineered shop drawings, outlining the manufacturer's recommended product for each piece of mechanical equipment. Submission shall be specific to the reviewed and returned shop drawings for equipment on the project.

1.3 OPERATION AND MAINTENANCE DATA

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

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 materials:

.1 Kinetics Noise Control

.2 Korfund

.3 Mason Industries

2.2 BASE TYPES

.1 Provide Base Type as indicated in Table under section 2.4 of this specification.

.2 Type A: No base, isolators attached directly to equipment. Refer to section 2.3 of this specification for isolator details.

.3 Type B: Steel Equipment Base. Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.

.1 Vibration bases for fans shall have adjustable motor slide rails and shall accommodate motor overhang.

.2 Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.

.3 Minimum clearance under steel equipment bases shall be 25 mm (1").

.4 Used with spring or rubber isolators. Refer to section 2.3 of this specification for isolator details.

.4 Type C: Concrete Inertia Base. Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate reinforcing bars, spaced 300 mm (12") maximum on centers each way.

.1 Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections.

.2 Inertia bases for fans shall include motor slide rails.

.3 The weight of each inertia base shall be sufficient to lower the center of gravity to or below the isolator support plane.

.4 Inertia bases shall be a minimum of 150 mm (6") thick.

.5 Used with spring isolators. Refer to section 2.3 of this specification.

.5 Type D: Roof Curbs

.1 Curb-Mounted Spring Rail:

.1 Full-perimeter rail type isolator, spring components shall be **1"/25 mm deflection**, free-standing, un-housed, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for 50% overload to solid.

2.3 ISOLATOR TYPES

.1 Provide Isolator Type as indicated in Table under section 2.4 of this specification.

.2 Type 1 (Neoprene and Fiberglass Isolation Pads)

.1 Type A:

.1 Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm2) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm2) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate.

.2 Type B:

.1 Isolation pads shall be neoprene elastomer in-shear pads, used in conjunction with steel shims where required, having static deflections as tabulated. Neoprene pads are produced from a high quality neoprene elastomer. Pads are 50 durometer and are designed for a maximum of 60 psi (4.2 kg. / sq. cm) loading. Pads are designed for a maximum deflection of approximately 20% of its unloaded thickness, 0.15" (0.38 cm).

.3 Type C:

.1 Vibration isolators shall be pre-compressed molded fiberglass pads individually coated with a flexible, moisture impervious elastomeric membrane. Vibration isolation pads shall be molded from glass fibers with all strands oriented horizontally. Natural frequency of fiberglass vibration isolators shall be essentially constant for the operating load range of the supported equipment.

.3 Type 2 (Fiberglass & Neoprene Isolation Mount & Hangers)

.1 Type A:

.1 Neoprene Hangers:

Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding 0.40" shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.

.2 Type B:

.1 Vertical Neoprene Isolators:

Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs.

.4 Type 3 (Free Standing Steel Springs)

.1 Type A:

.1 Free Spring Combination Ceiling Mounted Isolation Hangers:

Vibration isolators for suspended equipment with minimum static deflection requirement exceeding 0.4", and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a molded oil-resistant neoprene insert, complete with load transfer plates and assembled in stamped or welded steel bracket.

.5 Type 4 (Restrained Spring Isolators)

.1 Type A:

.1 Restrained Spring Floor Mounted Isolators:

Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup of a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized.

2.4 ROOF CURB ACOUSTIC LINING

.1 Design Basis: Kinetics RT-7

.2 Factory laminated acoustic panel. Panels to be sectional and modular, designed for easy and accurate field assembly.

.3 Panels to be minimum 7 – ¼" thick and comprised of alternating fiberglass absorption media and acoustically dampened sheet rock. Integrate additional layers as required to meet required STC rating.

.4 Provide on all HVAC equipment over 4,000 cfm capacity.

.5 Required STC Rating: 60.

2.5 MINIMUM DEFLECTION REQUIREMENTS BASED ON EQUIPMENT TYPE

.1 The following table is to be used to reference required base and isolator types, following the tagging convention outlined in Parts 2.2 and 2.3 above. Reference notes are detailed after the table.

				Equipment Location												
				Slab on Grade			Up to 20 ft (6 m) Floor Span			20 to 30 ft (6-9 m) Floor Span			30 to 40 ft (9-12 m) Floor Span			
Equipment Type	Equipment Category	Horsepower and Other	RPM	Base Type	Isolator Type	Min. Defl., in. (mm)	Base Type	Isolator Type	Min. Defl., in. (mm)	Base Type	Isolator Type	Min. Defl., in. (mm)	Base Type	Isolator Type	Min. Defl., in. (mm)	Reference Notes
Refrigeration Machines and Chillers	Reciprocating,	All	All	A	2	0.25	A	4	0.75	A	4	1.50	A	4	2.50	2
	Centrifugal, scroll	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A	4	1.50	2,4,8
	Screw	All	All	A	1	1.00	A	4	1.5	A	4	2.50	A	4	2.50	2,4
	Absorption	All	All	A	4	0.25	A	4	0.75	A	4	1.50	A	4	1.50	
	Air-cooled recip. scroll	All	All	A	1	0.25	A	4	1.50	A	4	1.50	A	4	2.50	2,4,5
	Air-cooled screw	All	All	A	4	1.00	A	4	1.50	B	4	2.50	B	4	2.50	2,4,5,8
	Air Source Heat Pumps	All	All	A	4	1.00	A	4	1.50	B	4	2.50	B	4	2.50	2,4,5,8
Pumps	Close-coupled	≤7.5	All	B	2	0.25	C	3	0.75	C	3	0.75	C	3	0.75	3
		≥7.5	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	3
	Inline	≤5	All	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50	
		≥7.5-25	All	C	3	1.50	C	3	1.50	C	3	1.50	C	3	2.50	
	End suction and double-suction/split case	≤40	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	3
		50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	2.50	3
		≥150	All	C	3	0.75	C	3	1.50	C	3	2.50	C	3	3.50	3
	Packaged pump systems	All	All	A	3	0.75	A	3	0.75	A	3	1.50	C	3	2.50	
Boilers	Fire-tube	All	All	A	1	0.25	B	4	0.75	B	4	1.50	B	4	2.50	4
	Water-tube, copper fin	All	All	A	1	0.12	A	1	0.12	A	1	0.12	B	4	0.25	

Axial Fans,	Up to 22 in. diameter	All	All	A	2	0.25	A	3	0.75	A	3	0.75	C	3	0.75	4,9,8
Plenum Fans,	24 in. diameter and up	≤2 in. SP	Up to 300	B	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50	9,8
Cabinet Fans,			301 to 500	B	3	0.75	B	3	1.50	C	3	2.50	C	3	2.50	9,8
Fan Sections,			501 and up	B	3	0.75	B	3	1.50	B	3	1.50	B	3	1.50	9,8
Centrifugal		≥2.1 in. SP	Up to 300	C	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50	8,9
Inline Fans			301 to 500	C	3	1.50	C	3	1.50	C	3	2.50	C	3	2.50	8,9
			501 and up	C	3	0.75	C	3	1.50	C	3	1.50	C	3	2.50	8,9
Centrifugal	Up to 22 in. diameter	All	All	B	2	0.25	B	3	0.75	B	3	0.75	B	3	1.50	7,9
Fans	24 in. diameter and up	≤40	Up to 300	B	3	2.50	B	3	3.50	B	3	3.50	B	3	3.50	7,8
			301 to 500	B	3	1.50	B	3	1.50	B	3	2.50	B	3	2.50	7,8
			501 and up	B	3	0.75	B	3	0.75	B	3	0.75	B	3	1.50	7,8
		≥50	Up to 300	C	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50	2,7,8,9
			301 to 500	C	3	1.50	C	3	1.50	C	3	2.50	C	3	2.50	2,7,8,9
			501 and up	C	3	1.00	C	3	1.50	C	3	1.50	C	3	2.50	2,7,8,9
Propeller Fans	Wall-mounted	All	All	A	1	0.25	A	1	0.25	A	1	0.25	A	1	0.25	
	Roof-mounted	All	All	A	1	0.25	A	1	0.25	B	4	1.50	D	4	1.50	
Heat Pumps, Fan-Coils, Computer Room Units	All	All	All	A	2	0.75	A	2	0.75	A	2	1.50	A/D	2	1.50	
Condensing Units	All	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A/D	4	1.50	
Packaged AH,	All	≤10	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	7
AC, H, and V		≤15	Up to 300	A	3	0.75	A	3	3.50	A	3	3.50	C	3	3.50	2,4,7,8
Units			301 to 500	A	3	0.75	A	3	2.50	A	3	2.50	A	3	2.50	4,7
		≤4 in. SP	501 and up	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50	4,7
		>15,	Up to 300	B	3	0.75	C	3	3.50	C	3	3.50	C	3	3.50	2,4,8,9
		>4 in. SP	301 to 500	B	3	0.75	C	3	1.50	C	3	2.50	C	3	2.50	2,4,9
			501 and up	B	3	0.75	C	3	1.50	C	3	1.50	C	3	2.50	2,4,9
Packaged Rooftop Equipment	All	All	All	A/D	1	0.25	D	3	0.75							5,8
Ducted	Small fans, fan-powered	≤600 cfm		A	1	0.50	A	1	0.50	A	1	0.50	A	1	0.50	
Rotating Equipment	boxes	≥601 cfm		A	1	0.75	A	1	0.75	A	1	0.75	A	1	0.75	

Base Types:

A. No base, isolators attached directly to equipment (Note 28)
B. Structural steel rails or base (Notes 29 and 30)
C. Concrete inertia base (Note 31)

Isolator Type:

1. Pad, rubber, or glass fiber
2. Rubber floor isolator or hanger
3. Spring floor isolator or hanger
4. Restrained spring isolator
5. Thrust restraint
6. Air spring

.2 Notes accompanying table:

.1 Cooling Towers: These are normally isolated with restrained spring isolators (type 4) directly under the tower or lower dunnage. High deflection isolators proposed for use directly under the motor-fan assembly must be used with extreme caution ensure stability and safety under all weather conditions. See Note 5.

.2 For large equipment capable of generating substantial vibratory forces and structure borne noise, increase isolator deflection, if necessary, so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.

.3 Pumps: Concrete inertia bases (type C) are preferred for all flexible-coupled pumps and are desirable for most close-coupled pumps, although steel bases (type B) can be used. Close-coupled pumps should not be installed directly on individual isolators (type A) because the impeller usually overhangs the motor support base, causing the rear mounting to be in tension. The primary requirements for type C bases are strength and shape to accommodate base elbow supports. Mass is not usually a factor, except for pumps over 55 kW, where extra mass helps limit excess movement due to starting torque and forces. Concrete bases (type C) should be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 20 kW, 150 mm; (2) for 30 to 55 kW, 200 mm; and (3) for 75 kW and up, 300 mm. Pumps over 55 kW and multistage pumps may exhibit excessive motion at start-up (“heaving”); supplemental re-straining devices can be installed if necessary. Pumps over 90 kW may generate high starting forces; a vibration specialist should be consulted.

.4 Certain designs cannot be installed directly on individual isolators (type A), and the equipment manufacturer should be consulted on the need for supplemental support (base type).

.5 Wind load conditions must be considered. Provide restrained spring isolators (type 4), supplemental bracing, snubbers, or limit stops.

.6 Compressors: Base-mounted compressors through 5 HP and horizontal tank-type air compressors through 10 HP can be installed directly on spring isolators (type 3) with structural bases (type B) if required, and compressors 15 to 100 HP on spring isolators (type 3) with inertia bases (type C) with a mass 1 to 2 times the compressor mass.

.7 Fans and Air-Handling Equipment:

.1 For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40% or less than the fan speed.

.2 Flexible duct connectors must be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission

.3 Inertia bases (type C) are required for all class 2 and 3 fans and air-handling equipment.

.8 To avoid isolator resonance problems, select isolator deflection so that resonance frequency is 40% or less of the lowest normal operating speed of equipment. Equipment such as variable-frequency drives, and high-speed equipment, such as screw chillers and vane axial fans, contain very-high-frequency vibration. To reduce high-frequency vibration transmission, add a 25 mm thick pad (type 1) to the base plate of spring isolators (type 3).

.9 To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor-mounted units operating at 1500 Pa or more total static pressure.

Part 3 Execution

3.1 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.2 Provide Roof Curb acoustic lining on all HVAC equipment above 4,000 cfm / 10 tonnes capacity.

.3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm (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").

.5 Where isolation is bolted to floor use vibration isolation rubber washers.

.6 Block and shim level bases so that ductwork and piping connections can be made to 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.

.7 Rooftop Units and Central Air Handling Units

.1 Packaged rooftop units shall be provided with standard curb mounted spring rails.

.2 Central air handling units (10,000 cfm or greater) shall be provided with spring isolation roof curbs.

.8 Spring isolators shall not be used in series to ensure no harmonics issues. This contractor shall review internally isolated equipment against method of spring isolation and ensure no overlap.

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.

.3 Standpipe and hose systems: To NFPA 14.

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
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Continuous blow-off	Yellow	CONT. BLOW-OFF
Glycol heating water supply	Yellow	GLYCOL HEATING WATER SUPPLY
Glycol heating water return	Yellow	GLYCOL HEATING WATER RETURN
Glycol cooling water supply	Yellow	GLYCOL COOLING WATER SUPPLY
Glycol cooling water return	Yellow	GLYCOL COOLING WATER RETURN
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 RELATED DOCUMENTS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

.1 Heating cable must conform to CSA 22.2 No.130-03 (latest edition).

1.3 SUMMARY

.1 Section includes heat tracing for fire-suppression piping with self-regulating, parallel resistance.

1.4 SUBMITTALS

.1 Product Data: For each type of product.

.2 Include:

- .1 Heating cable data sheet.
- .2 Connection kits and accessories data sheet.
- .3 Controller data sheet.
- .4 Controller wiring diagram.

.3 Include rated capacities, operating characteristics, and furnished specialties and accessories.

.4 Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.

.5 Include heat loss calculations for each pipe including pipe and insulation characteristics, heat loss, and watts per foot supplied by the heating cable.

.6 Shop Drawings: For electric heating cable.

- .1 Include plans, elevations, and sections.
- .2 Include diagrams for power, signal, and control wiring.
- .3 Manufacturer to produce detailed design as described below.

.7 Minimum heat trace capacity shall be 8 watts per foot irrespective of heat loss calculation.

.8 Pipe Freeze Protection Detail Drawings: Project-specific Detail Drawings, including details showing:

- .1 Installation and positioning of all components.
- .2 Proper amounts of tracing for valves, pumps, flanges, fittings, instruments, etc.
- .3 Junction box layouts.

.9 Control Panel Drawings: Drawings for each control panel shall include the following:

.1 Physical arrangement and detail drawings.

.2 Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices shall be numbered and tagged in accordance with system elementary diagrams.

.10 System Wiring Diagram: Project-specific drawings including:

.1 Interconnect of all major components.

.2 Assignment of circuiting.

.3 Connection of circuit wiring in terminal blocks.

.4 Connection of sensor wiring.

.5 Connection of external alarm wiring.

.11 Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat-tracing system.

1.5 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

.2 Testing: Completed system test report.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications:

.1 ISO-09001 registered.

.2 Provide products consistent with UL 515A, CSA 22.2 No 130-16, and IEEE 515.1 requirements.

.2 Installer Qualifications:

.1 System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.

.2 Electrical connections to be performed by licensed electrician.

.3 Certification: System (Heating Cable and Connection Kits): c-UL-us Listed for freeze protection of standpipes, mains, and branch fire sprinkler piping.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Deliver products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:

.1 Product and Manufacturer.

.2 Length/Quantity.

.3 Lot Number.

.4 Installation and operation Manual.

.5 Material Safety Data Sheet (MSDS).

.2 Store heating cable in clean, dry location with a temperature range of -18° to 60 C (0 to 140 F).

.3 Protect heating cable ends from moisture ingress until final termination of the heating cable is complete.

1.8 WARRANTY

.1 Manufacturer Limited Warranty: Manufacturer agrees to repair or replace heat tracing products listed below that fail in materials or workmanship within specified warranty period.

.2 Covered Products Include:

.1 Heating cables, connection kits, and accessories.

.2 Thermostats, controllers, panels, contactors, sensors, and accessories.

.3 Warranty Period: Two years from date of Ready for Takeover.

.4 Manufacturer's Extended Warranty: Provide Owner an extended product warranty for heat-tracing products for a period of 10 years from date of Ready for Takeover.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Complete pipe freeze protection system for insulated pipes exposed to the risk of freezing. System consists of a self-regulating heating cable, connection kits, accessories, and energy-efficient control and monitoring controller. The heating cable shall have a polyolefin jacket for aboveground fire sprinkler piping, including standpipes, mains, and branch fire sprinkler piping. The monitoring controller must be suitable for integration into the BAS.

2.2 PERFORMANCE REQUIREMENTS

.1 Manufacturer to design complete and functional heat-tracing system. Design must be signed and sealed by a professional engineer.

2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

.1 Basis of design product: Raychem or nVent XL-Trace.

.2 Comply with UL 515A, CSA 22.2 No 130-16, and IEEE 515.1 requirements.

.3 Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Cable shall be capable of crossing over itself once without overheating.

.4 Electrical Insulating Jacket: Flame-retardant modified polyolefin.

.5 Ground Braid: Tinned-copper braid. Minimum 70 percent for ground path and mechanical ruggedness.

.6 Outer Jacket: Modified polyolefin with ultraviolet inhibitor**.** Outer jacket to be printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).

.7 Maximum Operating Temperature (Power On): 154 F (68 C) for and **8 W/ft. (26 W/m)** required to suit load.

.8 Maximum Exposure Temperature (Power Off): 185 F (85 C).

.9 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

.10 Capacities and Characteristics:

.1 Nominal Heat Output at 10 C (50 F): 8 W/ft. (26° W/m) minimum. Provide higher as required based on heat loss calculations.

.2 Piping Diameter: Refer to plans.

.3 Electrical Characteristics for Single-Circuit Connection:

.1 Volts: 208

.2 Phase: Single.

2.4 HEATING CABLE CONNECTION KITS

.1 Basis-of-Design Product: RAYCHEM; RayClic.

.2 Provide power connections, splices/tees, and end seal kits to properly connect and terminate heating cable circuit along specified length of piping.

.3 Install splices, tees, and crosses underneath pipe insulation with service loops installed to allow for future service of piping.

.4 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require cutting into heating-cable core to expose bus wires.

.5 Certification: c-UL-us Listed

.6 Locate connection kits above grade for buried applications.

2.5 ACCESSORIES

.1 Cable Installation Accessories: Fiberglass tape, cable ties, connection kits, and end seals all furnished by manufacturer or as recommended in writing by manufacturer.

.2 Identification: Provide and install "Electric Heat Traced" labels on exterior of pipe insulation every 10 ft. (3m) on opposite sides of pipe, and on all splices, tees, crosses, and power connections for the entire length of heat traced piping.

.3 Thermal Pipe Insulation:

.1 Pipes to be thermally insulated in accordance with manufacturer's written requirements.

.2 Insulation shall be closed-cell in areas subject to freezing and have a flame/smoke spread rating of 25/50.

2.6 APPROVED MANUFACTURERS

.1 Approved manufacturers shall be:

.1 Chromalox
.2 Raychem
.3 3M
.4 Serge Baril
.5 Heron Cable Ind.
.6 Easy Heat (Emerson)

Part 3 Execution

3.1 EXAMINATION

.1 Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

.1 Prior to installation of heating cable system, verify that all piping, to be heat traced has passed all hydrostatic/pressure test and is signed off by plumbing inspector.

.2 Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

.2 Preinstallation Testing:

.1 Prior to installation of heating cable on piping, an insulation resistance test shall be performed by installing contractor to ensure integrity of heating cable as describe in installation and maintenance manual.

.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

.1 Protect all heating cable ends from moisture ingress until cable is terminated with end seals.

.1 Basis-of-Design Product: RAYCHEM; RayClic-E end seals.

3.3 INSTALLATION

.1 Install electric heating cable where indicated and in accordance with NFPA 70 and NFPA 13.

.2 All heat-tracing components including power connections, splices, tees, and crosses or end seal, must be installed above grade and protected from abuse or damage. In accordance with NEC and CEC, electrical connections are not permitted to be installed below grade.

.3 In the field, all heating cables shall be meggered with a minimum of 2,500 V dc for self-regulating cable. The following field megger readings shall be taken on each heating cable:

.1 Heating cable shall be meggered when received at Project site before installation.

.2 Heating cable shall be meggered after installation, but before insulation is installed.

.3 Heating cable shall be meggered after insulation is installed.

.4 Heating cable shall be meggered at final commissioning prior to being energized.

.5 Insulation resistance must exceed 1.000 megohms at 2,500 V dc.

.6 All results must meet manufacturer's specification.

.7 Test cables for electrical continuity during installation.

.8 Test insulation integrity before energizing.

.9 Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

.4 Install electric heating cables after piping has passed all hydrostatic pressure testing and before insulation is installed.

.5 Install electric heating cables in accordance with IEEE 515.1.

.6 Install insulation over piping with electric cables.

.7 Install warning tape on piping insulation where piping is equipped with electric heating cables.

.8 Set field-adjustable switches and circuit-breaker trip ranges.

.9 All heat trace cable shall be fastened to the steel pipes with plastic cable ties or fibreglass tape.

.10 The cable shall run the entire length of each pipe linearly.

.11 Power connection kits shall be installed in a weatherproof surface mounted junction box (suitable to house the connection kit) in the location shown on the drawings.

.12 Provide two runs of cable along the length of piping for all piping greater than or equal to 150mm (6" diameter). Run cable along top and bottom of entire pipe length or as per manufacturer’s recommendations.

.13 Electrical division shall provide power to junction box adjacent to heat trace circuit power connection. All other wiring shall be by this contractor to the standards of the electrical division.

3.4 MONITOR AND CONTROL PANEL

.1 Install in accordance with manufacturer’s instructions.

.2 Locate panel as indicated and mount securely. Plumb, true and square, to adjoining surfaces.

.3 Mount panel at working height. Maintain 1m clearance in front of panel.

3.5 CONNECTIONS

.1 Ground equipment to the requirements of the Electrical Division.

.2 Connect wiring in accordance with the requirements of the Electrical Division.

.3 Connect heat-tracing controls to fire-alarm system in accordance with NFPA 13. Comply with requirements of the Electrical Division.

3.6 FIELD QUALITY CONTROL

.1 Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system shall be performed by factory technician.

.1 System shall be commissioned in accordance with manufacturer’s installation and operation manual.

.2 Field Visits to be scheduled at the following intervals:

.1 Preinstallation training.

.2 Final electrical insulation resistance (megger) testing of heating cable after insulation has been installed.

.3 Final commissioning including controller programming (if applicable).

.3 Technician to verify:

.1 Controller parameters are set to the application requirements.

.2 Controller alarm contacts are properly connected to the BMS, as applicable.

.4 Test cables for electrical continuity during installation.

.5 Test insulation integrity before energizing.

.6 Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

.2 Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

.3 Cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's testing requirements.

.4 Prepare test and inspection reports.

3.7 PROTECTION

.1 Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.

.2 Remove and replace damaged heat-tracing cables.

3.8 INSTALLED LOCATIONS

.1 Install heat trace in all areas indicated on drawings and where subject to freezing. This includes, but is not limited to:

.1 Wet fire protection systems in unheated spaces.

.2 Drip legs of dry standpipe systems in unheated spaces.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ANSI/ASME B31.1, Power Piping.

.3 ANSI/ASME Boiler and Pressure Vessel Code:

- .1 Section 1: Power Boilers.
- .2 Section V: Nondestructive Examination.
- .3 Section IX: Welding and Brazing Qualifications.

.4 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.

.5 CSA W48, Filler Metals and Allied Metals for Arc Welding.

.6 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

.7 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes.

.8 CSA W178.1, Certification of Welding Inspection Organizations.

.9 CSA W178.2, Certification of Welding Inspectors.

.10 AWS B2.1, Specification for Welding Procedure and Performance Qualification.

.11 AWS C1.1, Recommended Practices for Resistance Welding.

.12 AWS W1, Welding Inspection.

.13 ANSI/AWWA C206, Field Welding of Steel Water Pipe.

1.2 WELDERS QUALIFICATIONS

.1 Welding qualifications to be in accordance with CSA B51.

.2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction.

.3 Furnish welder's qualifications to Consultant.

.4 Each welder to possess identification stamp issued by authority having jurisdiction.

.5 Certification of companies for fusion welding of aluminum to be in accordance with CSA W47.2.

1.3 INSPECTORS QUALIFICATIONS

.1 Inspectors to be qualified to CSA W178.2.

1.4 WELDING PROCEDURES

.1 Registration of welding procedures in accordance with CSA B51.

.2 Copy of welding procedures to be available for inspection at all times.

.3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2.

Part 2 Products

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

Part 3 Execution

3.1 WORKMANSHIP

.1 Welding to be in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of provincial authority having jurisdiction.

.2 Protect all adjacent areas.

3.2 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification stamp.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 50 mm (2") and smaller: install welding type sockets.

.2 Branch connections: install welding tees or forged branch outlet fittings.

3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS

.1 Review all weld quality requirements and defect limits of applicable codes and standards with Consultant before any work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Consultant.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

.4 Provide for inspector to visually inspect all welds during early stages of welding procedures in accordance with AWS W1. Repair or replace all defects as required by codes and as specified herein.

3.4 SPECIALIST EXAMINATIONS AND TESTS

.1 General.

.1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant.

.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.

.3 Inspect and test 25% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and/or full gamma ray radiographic (hereinafter referred to as "radiography") tests as specified.

.2 Hydrostatically test all welds to requirements of ANSI/ASME B31.1.

.3 Visual examinations: include entire circumference of weld externally and (wherever possible) internally.

.4 Failure of visual examinations:

.1 Upon failure of any weld by visual examination, perform additional testing as directed by Consultant of a total of up to 10% of all welds, selected at random by Consultant by radiographic tests.

3.5 DEFECTS CAUSING REJECTION

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

.2 In addition, hydronic water systems:

.1 Undercutting greater than 0.8 mm (1/32") adjacent to cover bead on outside of pipe.

.2 . Undercutting greater than 0.8 mm (1/32") adjacent to root bead on inside of pipe.

.3 Undercutting greater than 0.8 mm (1/32") at combination of internal surface and external surface.

.4 Incomplete penetration and incomplete fusion greater than total length of 40 mm (1 1/2") in any 1500 mm (60") length of weld depth of such defects being greater than 0.8 mm (1/32").

.5 Repair all cracks and defects in excess of 0.8 mm (1/32") in depth.

.6 Repair defects whose depth cannot be determined accurately on the basis of visual examination or particle tests.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

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

3.7 CLAIMS AGAINST OWNER FOR DELAYS

.1 Claims against Owner for delays in completion of project will not be entertained for reasons of failures of welds to pass examinations.

3.8 OCCUPIED AREAS

.1 Do not do any “Hot Work” in occupied areas.

.2 Obtain “Hot Work” permits for working in existing building.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This Section is to be read in conjunction with Division 1, the General Conditions and Section 20 02 51, the General Requirements of the Mechanical Trades, and the documents required by the BIDDING REQUIREMENTS and CONDITIONS OF THE CONTRACT sections.

.2 All pricing shall be in accordance with Catholic School Board Services Association (CSBSA) Agreement.

.3 All pricing submissions shall include the following supporting documents; Detailed List Summary, Poteau Analysis, Project schedule and summary letter.

.4 The balancing contractor will work for the Owner.

.5 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.

1.2 APPROVED TAB AGENCIES

.1 Bids for the balancing contractor will be tendered separately by the School Board.

1.3 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.

1.4 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.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

.7 Control valves are properly piped.

.8 Coils and radiation are properly piped.

.9 BAS in operation.

1.11 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 10%, minus 5%.

.2 Hydronic systems: plus or minus 10%.

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 HYDRONIC SYSTEMS

.1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.

.2 Standard: TAB to be the most stringent of TAB standards of NEBB, AABC, SMACNA, ASHRAE.

.3 Do TAB of all systems, equipment, components, controls specified in Mechanical Division including but not limited to hydronic equipment testing.

.4 Qualifications: personnel performing TAB to be current member in good standing of NEBB.

.5 Quality assurance: perform TAB under direction of qualified supervisor.

.6 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power voltage, noise, vibration.

.7 Locations of equipment measurement: To include, but not be limited to, following as appropriate:

.1 Inlet and outlet of each heat exchanger (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.

.2 At each controller, controlled device.

.8 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each primary and secondary loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

1.22 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.

1.23 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.

1.24 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 Pressure booster systems: test for capacity and pressures under all conditions and at all times.

.2 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.

1.25 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:

Positive	Negative
Corridors	Washrooms
Cafeteria	Cafeteria Kitchen (Kitchen maximum -0.02 inches w.c.)
Corridors	Industrial Areas

.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 Smoke management systems:

.1 Test for proper operation of all smoke and fire dampers installed as component parts of air systems specified.

.6 Provide duct testing as specified.

.7 Provide AHU testing as specified.

.8 Provide plenum testing as specified.

.9 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 piping systems
- Independent contractor balancing of water systems
- 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
- Pumps - RPM, impeller sizes, rated flow
- Fans - belt type and size, shive type and size
- Electrical - volts, amps, fuse size, overload size
- Any other special characteristics.

3.4 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.

3.5 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 Mechanical Contractor and shall report to the Commissioning Consultant.

3.6 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.

3.7 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.

3.8 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:

- Heat Pumps
- Condensing Units
- Boilers and Pumps
- Air Handling Units
- Cooling Tower
- Life Safety and Fire Protection Systems
- Water Treatment 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.

3.9 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

3.10 OPERATION AND MAINTENANCE MANUAL

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

3.11 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:

System	Minimum Training Times
Condensing Units	2 hours
Boilers	2 hours
Air Handling Units	2 hours
Life Safety & Fire Protection Systems	2 hours
Water Treatment 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.

3.12 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.

3.13 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.

3.14 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.

3.15 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.

3.16 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 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 Proprieties by Mean of the Guarded Hot-Plate Apparatus.

.2 ASTM C518 Standard Test Method for Steady-State Thermal Transmission Proprieties 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^2•°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^2•°F)

.5 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/m² (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 Prefinished Steel

.1 To ASTM with moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.5 mm (26 gauge) sheet.

.3 Finish: Smooth/Galvanised.

.4 Jacket banding and mechanical seals: 15 mm (1/2") wide, 0.50 mm (26 gauge) thick stainless steel.

.3 Aluminum:

.1 To ASTM C1729 with moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.5 mm (0.020") sheet.

.3 Finish: Smooth.

.4 Jacket banding and mechanical seals: 15 mm (1/2") wide, 0.5 mm (0.020") thick stainless steel.

.5 Provide exterior silicone sealant on all joints.

.6 Self-adhesive aluminum jackets are not permitted.

.4 Stainless steel:

.1 Type: 304 to ASTM C1767 with moisture barrier.

.2 Thickness: 0.25 mm (0.10") sheet.

.3 Finish: Smooth.

.4 Jacket banding and mechanical seals: 15 mm (1/2") wide, 0.5 mm (0.020") thick stainless steel.

.5 Colour: As selected by consultant.

.5 Self adhesive aluminum:

.1 Aluminum skin with adhesive, minimum thickness 1.5 mm (60 mils).

.2 Modified SBS membrane.

.3 Ultra violet light resistance.

.4 Puncture and tear resistant.

.5 Multi standard colours (selected by architect).

.6 Overlap joints minimum of 50 mm (2").

.7 Acceptable Manufacturers:
.1 Foilskin (Bakor)

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/m² (6oz/yd^2) 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.

.7 **Use two layers with staggered joints when required nominal thickness exceeds 75 mm (3").**

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")
Supply, return, and fan exhaust ducts exposed (visible) in space being served	None	
Energy/heat recovery ventilator Exhaust ducts	C-1	25 mm (1")
Outdoor air ducts (exterior ductwork)	C-1	80 mm (3")
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")
Indoor AHU relief air ducts	C-1	25 mm (1")
Exterior ductwork	C-1	80 mm (3")

.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

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 ASTM C612, Mineral Fiber Block and Board Thermal Insulation.

.3 CGSB 51-GP-52Ma, 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 C1729 Standard Specification for Aluminium Jacketing for Insulation.

.2 ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fibre Roll and Sheet Thermal Insulation for Pipes and Tanks.

.3 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.4 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.5 ASTM C177 Standard Test Method for Safety-State Heat Flux Measurements and Thermal Transmission Proprieties by Means of the Guarded-Hot-Plate Apparatus.

.6 ASTM C518 Standard Test Method for Steady-State Thermal Transmission Proprieties by Means of the Heat Flow Meter Apparatus.

.7 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.8 ASTM C449, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.9 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.

.10 ASTM C921, 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 PRODUCT DATA

.1 Submit Product Data in accordance general requirements.

1.3 SAMPLES SUBMITTALS

.1 Submit samples in accordance with general requirements.

.2 Submit for approval: completed detail plate assemblies of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 15 mm (1/2") plywood board. Affix typewritten label beneath sample indicating service.

1.4 INSTALLATION INSTRUCTIONS

.1 Submit properly completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specification section.

.2 Submit manufacturer's installation instructions in accordance with general requirements.

.3 Installation instructions to include procedures to be used, installation standards to be achieved.

1.5 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.

1.6 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.

1.7 DEFINITIONS

.1 For purposes of this section:

.1 “CONCEALED” – insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 “EXPOSED” – will mean “not concealed” as defined herein.

.3 “Insulation Systems” – insulation material, fasteners, jackets, and other accessories.

.4 “ASJ+” All Service Jacket – vapor retarded laminate of aluminium foil inner layer reinforced with fibreglass scrim, bonded to a bleached kraft paper with outer poly film layer leaving no paper exposed.

.5 "ASJ" All Service Jacket – (no outer film) vapor retarder laminate of aluminum foil inner layer reinforced with fibreglass scrim, bonded to a bleached kraft paper outer layer.

.6 "FSK" Foil Scrim Kraft – vapor retarder laminate of aluminium foil outer layer, reinforced with fibreglass scrim, bonded to a natural kraft paper inner layer.

.7 "PSK" Poly Scrim Kraft – vapor retarder laminate of polypropylene outer layer, reinforced with fibreglass scrim, bonded to a natural kraft paper inner layer.

.8 "PVC" Poly Vinyl Chloride – polymer to manufacture non-metallic final protective finish jacket over insulation systems.

Part 2 Products

2.1 LIMITATION ON MATERIALS

.1 Product 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 C177 or ASTM C518.

.3 Type A-1: Fibre glass 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 FT^2 x °F

.4 Jacket: specified in 'Factory-Applied Jackets' Article

.4 TypeA-6: Flexible unicellular tubular elastomer.

.1 Insulation: to ASTM C553 with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

.4 To be certified by manufacturer to be free of potential stress corrosion cracking corrodents.

2.4 CEMENT

.1 Hydraulic setting cement

.1 To ASTM C449

.2 Air setting cement

.1 To ASTM C195

.3 Hydraulic setting cement shall be used for all finishing work and areas where equipment is not concealed.

2.5 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: white

.3 Minimum service temperatures: -29°C (-20°F).

.4 Maximum service temperature: 65°C (150°F).

.5 Moisture vapour transmission: 0.05 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks (not to be used on systems and equipment that operate at below ambient temperatures to avoid punctures in vapor retarder system).

.3 Pressure sensitive vinyl tape of matching colour.

.7 Covering adhesive: Compatible with insulation.

.2 Canvas:

.1 220 g/m² (6 oz/sq yd) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: Compatible with insulation.

2.6 INSULATION SECUREMENTS

.1 Tape: Self-adhesive, aluminum, [reinforced], 50 mm (2") wide minimum.

.2 Contact adhesive: Quick setting.

.3 Canvas adhesive: Washable.

.4 Tie wire: 1.5 mm (16 gauge) diameter stainless steel.

.5 Bands: Stainless steel, 20 mm (3/4") wide, 0.5 mm (26 gauge) thick.

.6 Facing: 25 mm (1") galvanized steel hexagonal wire mesh on one face of insulation.

.7 Fasteners: 4 mm (5/32") diameter pins with 40 mm (1½") clips. Length of pin to suit thickness of insulation. Pins to be CD weld, self-adhesive or glue applied – to be selected and confirmed with consultant in accordance with required service conditions.

2.7 VAPOUR RETARDER LAP ADHESIVE

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

2.8 INDOOR VAPOUR RETARDER FINISH

.1 Compatible with insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping 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 TIAC and North American Commercial and Industrial Insulation Standards.

.1 Hot equipment: To TIAC code 1503-H.

.2 Cold equipment: to TIAC code 1503-C.

.2 Provide a completely insulated system allowing for insulation over all valves, fittings, air separators, pumps, buffer tanks, and other connected equipment to the system.

.3 Elastomeric Insulation: to remain dry at all times. Overlaps to be to manufacturer instructions. Joints to be tight and sealed properly.

.4 Provide vapour retarder as recommended by manufacturer.

.5 Apply materials in accordance with insulation and equipment manufacturers instructions and this specification.

.6 Below ambient/chilled water installation:

.1 All pipes, fittings, valves, strainers, flanges, unions, and other pipe system components and specialties must be properly insulated with correctly completed vapor retarded 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 .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 specialities.

.5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricated from the same material as the pipe insulation. Full thickness must be 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 or 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 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.

.7 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3").

.8 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

.9 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Flexible removable blanket insulation covers are not acceptable for below ambient (cold) operating piping systems. Rigid removable insulation jackets of the vapor retarder exterior material that can be vapor sealed at the seams, are acceptable on below ambient (cold) operation piping systems.

.2 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.

.3 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation. Fabricate flexible, removable insulation in accordance with ASTM C 1695, Standard Specification for fabrication of flexible removable and reusable blanket insulation for hot service.

3.4 EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges, air separators, and fittings unless otherwise specified.

.2 Hot Equipment:

.1 Type and Thickness:

ITEM	THICKNESS	TYPE
Hot water heating tanks	25 mm (1")	A1
Heat exchangers	50 mm (2")	A1
Low Loss Headers	50 mm (2”)	A1
Hot Water Pumps	**25 mm (1”)**	**A1**
Air Separator	25mm (1”)	A1

.3 Cold equipment:

.1 Type and Thickness:

ITEM	THICKNESS	TYPE
Chiller	50 mm (2")	A-6
Chilled Water Tanks	50 mm (2")	A-6
Expansion Tanks	50 mm (2")	A-6
Heat Exchangers	50 mm (2")	A-6
Pumps	50 mm (2")	A-6
Air Separator	50 mm (2")	A-6

.4 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with canvas jacket.

.2 Equipment elsewhere: TIAC code CEF/2 with canvas jackets.

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-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 Specification for Mineral Fiber Pipe Insulation.

.2 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Proprieties by Means of the Guarded-Hot-Plate Apparatus.

.3 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Proprieties by Means of the Heat Flow Meter Apparatus to recognize the correct thermal insulation performance testing for blanket.

.4 ASTM C1393, Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks

.5 ASTM C1695, Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service.

.6 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.7 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.

.8 ASTM C1729 Standard Specification for Aluminium Jacketing for Insulation.

.9 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.10 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment 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 properly completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specific section.

.3 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves, and jointing recommendations.

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, 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.

.5 “FSK” – Foil Scrim Kraft – vapor retarder laminate of aluminum foil outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner liner.

.6 "PSK" – Poly Scrim Kraft – vapor retarder laminate of polypropylene outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner layer.

.7 "PVC" – Poly Vinyl Chloride – polymer used to manufacture a non-metallic final protective finish jacket over insulation systems.

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 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, ASTMC177 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-3: Tubular flexible elastomeric closed cell foam:

.1 Insulation to ASTM C534 Type I.

.2 Maximum "k" factor: to ASTM C534.

.3 To be certified by manufacturer to be free of potential stress corrosion cracking corrodents.

.5 Materials:

.1 All materials must be supplied by the same manufacturer.

.2 Acceptable Manufacturers:

.1 Knauf

.2 Manson

.3 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.

.4 Tie wire: 1.5mm (16 gauge) diameter stainless steel.

.5 Bands: Stainless steel, 20 mm (3/4") wide, 0.5 mm (0.020") thick.

2.5 CEMENT

.1 Thermal insulating and finishing cement:

.1 Air drying on mineral wool, to ASTM C 449M.

.2 Hydraulic setting on mineral wool, to ASTM C165

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 OUTDOOR VAPOUR RETARDER FINISH

.1 Compatible with insulation.

.2 Reinforcing fabric: Open weave fibreglass fabric, with maximum weave of 10 x 10 squares per inch.

2.9 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 Minimum thickness: 20mil (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 (not to be used on below-ambient temperature systems)

.3 Pressure sensitive vinyl tape of matching colour.

.2 Aluminum:

.1 To ASTM C1729.

.2 Thickness: 0.50 mm (0.020") sheet.

.3 Finish: Smooth.

.4 Joining: Longitudinal and circumferential slip joints with 50 mm (2") laps.

.5 Fittings: 0.50 mm (0.020") thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 20 mm (3/4") wide, 0.50 mm (0.020") thick at 300 mm (12") spacing.

.3 Canvas:

.1 220 g/m^2 (6oz/sq yd) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

.4 Stainless steel:

.1 Type: [304].

.2 Thickness: 0.25 mm (0.010").

.3 Finish: Smooth

.4 Joining: Longitudinal and circumferential slip joints with 50 mm (2") laps.

.5 Fittings: 0.50 mm (0.020") thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 20 mm (3/4") wide, 0.50 mm (0.020") thick at 300 mm (12") spacing.

2.10 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 North American Commercial and Industrial Insulation Standards.

.2 Provide continuous insulation for complete systems including all valves, air separators, fittings, and other equipment.

.3 Apply materials in accordance with manufacturers' instructions and this specification.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

.6 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3").

.7 Below ambient/chilled water installation:

.1 All pipes, fittings, valves, strainers, flanges, unions, and other pipe system components and specialties must be properly insulated with correctly completed vapor retarded 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 .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 specialities.

.5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricated from the same material as the pipe insulation. Full thickness must be 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 or 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 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, PREFABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.

.2 Flexible removable 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 Insulation:

.1 Insulation, fastenings, and finishes: same as system.

.2 Jacket: As per adjacent insulation.

3.4 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges, air separators, 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.

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
Hot Water Heating	A-1	40 (1½")	50 (2")	50 (2")	50 (2")	50 (2")
Glycol Heating	A-1	40 (1½")	50 (2")	50 (2")	50 (2")	50 (2")
Chilled Water Piping	A-3	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Chilled Water Pump Casings	A-3	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Refrigerant piping	A-3	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")

.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
Within 300 mm (12") of boiler	CANVAS	CANVAS
Exterior piping	Stainless Steel	Stainless Steel
Exterior refrigerant piping	Aluminum	Aluminum

.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 B16.5, 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^3 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 CONTRACTOR PROVIDED GAS METERS

.1 This contractor shall provide a gas meter complete with digital pulse for connection to the BAS system for where indicated on the drawings.

.2 The gas meter shall be compatible with the requirement of the local utility and BAS contractor.

.3 Acceptable materials: Badger Meter Inc. (Line Process Controls 1-416-291-8525).

2.8 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.

2.9 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

2.10 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 SUPERVISORY SWITCH

.1 Install on valves as indicated to monitor open/closed position of valve and send signal to fire alarm system. Install to manufacturer's recommendations.

3.5 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.

3.6 PURGING

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

3.7 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.

3.8 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 Canadian Standards Association (CSA).

.1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

.3 American Society for Testing and Materials (ASTM).

.1 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.

.2 ASTM A278/A278M, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F (350°C).

.3 ASTM A516/A516M, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.

.4 ASTM A536, Specification for Ductile Iron Castings.

.5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.

.4 American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME, Boiler and Pressure Vessels Code (BPVC).

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Indicate on manufacturers' catalogue literature the following:

.1 Sizes, orientation, capacities, performance, etc.

.2 Accessories

1.3 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 BLADDER TYPE EXPANSION TANK

.1 Vertical galvanized steel pressurized bladder type expansion tank.

.2 Quantity, size, and capacity as shown on the drawings.

.3 Working pressure: 860 kPa (125 psi) with ASME stamp and certification.

.4 Air precharged to 84 kPa (12 psi) (initial fill pressure of system).

.5 Base mount for vertical installation.

.6 Suitable for glycol services when specified.

.7 Acceptable Manufacturers:

.1 Amtrol

.2 Armstrong

.3 Bell & Gossett

2.2 AIR SEPARATOR EXPANSION TANK FITTING

.1 Complete with adjustable vent tube and built-in manual vent valve.

.2 Working pressure: 860 kPa (125 psi).

2.3 COMBINATION COALESCING AIR & DIRT SEPARATOR/STRAINER

.1 Steel, tested and stamped in accordance with ANSI/ASME BPVC, for 860 kPa (125 psi) operating pressure, with galvanized steel integral strainer with 5 mm (3/16") perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube. Separator to be complete with flanged TOP access (removable).

.2 Removes free air and entrained air from hydronic system.

.3 Non-removable end cover, and connections for an air vent, blow down valve, and skim valve.

.4 Stainless steel coalescing medium with 58% open area.

.5 High powered switchable on/off style magnet.

.6 Constructed, inspected, and stamped per Section VIII, Division 1 of the ASME code for 150 psi (1,034 kPa) maximum working pressure and 450°F (232°C) maximum working temperature

.7 Size: to match line size piping.

.8 Acceptable material:

.1 Bell & Gossett

.2 Taco

2.4 COMBINATION LOW PRESSURE BUFFER TANK (BT-1)

.1 Furnish and install, as shown on plans. The tank shall incorporate a baffle to promote tank water storage temperature stratification. The system water connections must be 6” (flanged). The CBT must be constructed in accordance with the most recent addendum of Section VIII Division 1 of the ASME Boiler and Pressure Vessel Code and constructed and stamped for 150 PSI working pressure @ 450°F.

.2 Tank to be field insulated. Refer to specification section 23 10 16.

.3 Acceptable material:

.1 Wessels Model CBT- 500 – BT-1 Chilled Water Buffer Tank

2.5 COMBINATION SEPARATORS STRAINERS

.1 Steel, tested and stamped in accordance with ANSI/ASME BPVC, for 860 kPa (125 psi) operating pressure, with galvanized steel integral strainer with 5 mm (3/16") perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

.1 Size: to match piping.

.2 Acceptable Manufacturers:

.1 To be of the same manufacturer of base mounted pumps.

2.6 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

.1 Adjustable pressure setting: 206 kPa (30 psi) relief, 55 to 172 kPa (8.0 to 25 psi) reducing.

.2 Low inlet pressure check valve.

.3 Removable strainer.

2.7 PIPELINE STRAINER

.1 Pipeline strainer shall provide a means of mechanically removing solids from a flowing fluid. This is accomplished by utilizing a perforated metal mesh.

.2 Strainers shall be installed in pipelines to protect downstream mechanical equipment such as condensers, heat exchangers, pumps, compressors, meters, spray nozzles, turbines, and steam traps from the detrimental effect of sediment, rust, pipe scale, or other extraneous debris.

.3 Types of strainers: Provide strainers that are Y strainer and/or basket strainer.

.4 Strainer end connections shall match the piping specification.

.1 NPS 15 mm to 50 mm (1/2" to 2"): bronze body to ASTM B62, screwed connections.

.2 NPS 65 mm to 300 mm (2 1/2" to 12"): cast steel body to ASTM A278M, Class 30, flanged connections.

.3 NPS 50 mm to 300 mm (2" to 12"): T type with malleable iron body to ASTM A47M, grooved ends.

.5 Strainer components shall include a cover, perforated plate, mesh, wedge wire, gasket, and cover fasteners.

.1 Perforated Plate/Mesh/Wedge Wire: Stainless steel (various grades available).

.2 Gaskets: to suite fluid application.

.3 Fasteners: to match body material.

.6 Mesh sizing:

.1 An extremely important consideration in the selection of a strainer is the size of the perforations, mesh or wire opening used in the fabrication of the straining element. Select holes that are actually needed for the application and specified by the equipment manufacturer’s request that is being protected.

.2 The following tables illustrate mesh and their respective straining capability. The main criteria for choosing hole and mesh size is the size and quantity of particles which can pass through downstream equipment without causing damage.

Mesh (Openings/In.)	Wire Diameter (In.)	Opening		Percent Open Area
		Inches	Micron	
10	0.032	0.068	727	56.3
16	0.018	0.045	1130	50.7
18	0.017	0.036	979	48.3
20	0.015	0.035	889.0	49.0
30	0.011	0.0223	566.4	44.8
40	0.009	0.0156	396.2	40.2
50	0.009	0.011	279	30.3
60	0.0065	0.0102	259.1	37.3
80	0.005	0.0075	190.5	36.0
100	0.0045	0.0055	139.7	30.3
120	0.0035	0.0048	123	30.1
150	0.0026	0.0041	103	37.2
170	0.0024	0.0035	79	35.1
200	0.0020	0.0030	76.2	33.6
250	0.0016	0.0024	61	36.0
300	0.0012	0.0021	54.2	29.7
325	0.0012	0.0019	47.7	30.0
400	0.0011	0.0014	35.6	36.0

.7 Capacity: The capacity ratio or open area ratio (OAR) of a strainer influences such operating characteristics as the length of time it can operate without cleaning and the created pressure loss. The OAR is the relationship between internal cross sectional area (flow area) of the pipe and the open flow area of the material which makes up the straining element.

.1 The OAR for wye strainers shall not be less than 2.5:1.

.2 The OAR for basket strainers shall not be less than 7:1.

.3 When considering the OAR of a straining element, there are two accepted methods of analysis used by various specifying agencies and manufacturers. One method maintains “line of sight” reasoning and uses the multiple of the open areas for elements in series. In this method, a 60% open area material in series with a 40% open area material has a resultant combined open area of 24% (i.e. as in accordance with Military Standards). An alternative method allows the open area of the more restrictive element in series to be used. This would be 40% for the example above (i.e. as in accordance with Underwriter Laboratories’ Standards). The method used influences the estimated operating pressure drop, as well as design decisions such as sizing.

.8 Strainers are made with various dimensions and configurations; manufacturers have tested and published pressure drop results.

.1 Provide strainers designed for reasonable velocities that permit approximately 2 psi pressure drop across the strainer.

.2 Provide basket strainers designed for reasonable velocities that permit approximately 0.5 psi pressure drop across the strainer.

.9 To allow the manufacturer to make selection or recommendations for a particular strainer, as much as possible, the following information should be provided by the Contractor to the Supplier:

.1 Physical Characteristics

.1 Pipe size and schedule.

.2 Strainer type required.

.3 End connections.

.4 Material (body, screen, bolting, gaskets).

.5 Pressure rating (design/operating — including shock).

.6 Temperature rating (design, operating, minimum).

.7 Straining element opening size.

.8 Capacity:

.1 Net effective open area required.

.2 Method of net open area calculation.

.9 Special requirements (hinged cover, vent tapping, jacketed, etc.).

.10 Applicable specifications (military specifications, special non-destructive tests or other quality control requirements).

.2 Flow Data

.1 Liquid:

.1 Description of fluid.

.2 Rate of flow – gallons per minute (gpm) or pounds per hour (lbs/hr).

.3 Viscosity – SSU.

.4 Specific gravity or density.

.5 Temperature.

.6 Concentration (if acid or other corrosive).

.2 Gas:

.1 Description of Gas.

.2 Rate of flow – standard cubic feet per minute (scfm) or actual cubic fee per minute (cfm).

.3 Specific gravity.

.4 Temperature and pressure.

.5 Molecular weight.

.3 Steam:

.1 Rate of flow-pounds per hour (lbs/hr).

.2 Temperature.

.3 Pressure.

.4 Density.

.5 State of flow.

.10 Blowdown connection: NPS 25 mm (1").

.11 Screens at pumps: stainless steel with 1.19 mm (50 mil) perforations (16 mesh).

.12 Working pressure: 860 kPa (125 psi).

2.8 LOW WATER CUT-OFF

.1 Packaged low water cut-off with heavy duty construction, 16A relay.

.2 Operates on 24V AC, or 120V switching capacity: 5.8 FLA, 24.8 LRA, Max load: 16A, switch contacts: SPDT, 250 psi max pressure, 250°F max water temperature.

.3 Burner circuit locks out, if water remains below probe for 30 s. Manual reset will not trip due to power failure.

.4 Burner circuit test button.

.5 Indicator lights for troubleshooting.

.6 Acceptable Manufacturers:

.1 Hydro Level Company Safgard 500 or 550.

Part 3 Execution

3.1 GENERAL

.1 Install as indicated and to manufacturer's recommendations.

.2 Run drain lines (and blow off connections) to terminate above nearest drain.

.3 Maintain proper clearance to permit service and maintenance.

.4 Should deviations beyond allowable clearances arise, request, and follow Consultant's directive.

.5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

3.2 STRAINERS

.1 Install in horizontal or down flow lines.

.2 Ensure clearance for removal of basket.

.3 Install ahead each of the following components:

.1 Pumps

.2 Temperature control valves

.3 Condensers

.4 Boilers

.5 Brazed plate heat exchanger

.6 Compressors

.7 Meters

.8 Spray nozzles

.9 Additional locations where indicated on the drawings.

.4 Provide proper mesh strainers for the proper application.

.5 Provide proper mesh strainers as recommended by the manufacturer's product being protected.

.6 Provide basket strainers ahead of all plate heat exchanger or equipment with plate heat exchanger when piping is 100 mm (4") and larger.

.7 The strainer must be installed such that the debris chamber is located at the lowest possible position. A Y strainer in vertical piping must be placed with its screen in the downward position to trap the sediment in the debris collection chamber.

.8 Provide with a blowdown so the element can be flushed out by opening and closing the blowdown valve. This shall be accomplished without flow stoppage or disassembling any piping.

3.3 EXPANSION TANKS

.1 Adjust expansion tank pressure to suit system pressure at installed location or noted design pressure. Where discrepancies between plans and system pressure exist notify consultant.

.2 Set pressure in accordance with ASME Boiler and Pressure Vessel Code.

.3 Ensure boiler temperature and pressure relief is adequate for system at high temperature and pressure. Test operation on site.

.4 Maintain a minimum of105 kpa (15 psig) as the lowest pressure point.

.5 Install isolation ball valve and union at inlet to tank.

3.4 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.5 AIR SEPARATOR

.1 Provide independent support from structure.

.2 Provide high capacity air vent as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 Canadian Standards Association (CSA).

.1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

.3 American National Standards Institute (ANSI).

.1 ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

.2 ANSI/ASME B16.3, Malleable-Iron Threaded Fittings, Classes 150 and 300.

.3 **ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS½ through NPS24 Metric/Inch.**

.4 **ANSI/ASME B16.9, Factory-Made Wrought Steel Buttwelding 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 **ANSI/ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).**

.7 **ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.**

.4 American Society for Testing and Materials (ASTM).

.1 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM A536, Specification for Ductile Iron Castings.

.4 ASTM B61, Specification for Steam or Valve Bronze Castings.

.5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.

.6 **ASTM E202, Test Method for Analysis of Ethylene Glycols and Propylene Glycols.**

.5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS-SP-67, Butterfly Valves.

.2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Indicate on manufacturers' catalogue literature the following:

.1 Piping

.2 Valves

.3 Accessories

1.3 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 STEEL PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

.1 NPS 150 mm (6") and smaller: Schedule 40.

.2 Final connection to copper heating elements.

.1 Type "L" copper with 95/5 solder joints and dielectric couplings. Maximum length 600 mm (24").

.3 Pipe Joints

.1 NPS 50 mm (2") and under: screwed fittings with pulverized lead paste.

.2 NPS 65 mm (2½") and over: welding fittings and flanges to CSA W47.1.

.3 Flanges: plain or raised face, slip-on.

.4 Flange gaskets: suitable for hydronic heating up to 110°C (220°F).

.5 Pipe thread: taper.

.6 Bolts and nuts: to ANSI B18.2.1 and ANSI/ASME B18.2.2.

.4 Fittings

.1 Screwed fittings: malleable iron, to ANSI/ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ANSI/ASME B16.1, Class 125.

.2 Steel: to ANSI/ASME B16.5.

.3 Butt-welding fittings: steel, to ANSI/ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.

2.2 VALVES

.1 Connections:

.1 NPS 32 mm (1 1/4") and smaller: screwed ends.

.2 NPS 50 mm (2") and smaller: screwed ends.

.3 NPS 65 mm (2 ½") and larger: flanged ends.

.2 Gate valves: Application: Isolating equipment, control valves, pipelines:

.1 NPS 50 mm (2") and under:

.1 Mechanical Rooms: Class 125, rising stem, solid wedge disc.

.2 Elsewhere: Class 125, non-rising stem, solid wedge disc.

.2 NPS 65 mm (2 1/2") and over:

.1 Mechanical Rooms:

.1 Rising stem, solid wedge disc, bronze trim.

.1 Operators: handwheel.

.2 Non-rising stem, solid wedge disc, bronze trim.

.1 Operators: handwheel.

.3 Butterfly valves: Application: Isolating each cell or section of multiple component equipment and where indicated.

.1 NPS 32 mm (1 1/4") and smaller: screwed ends.

.2 NPS 50 mm (2") and smaller: screwed ends.

.3 NPS 65 mm (2 1/2") and over: Flanged ends.

.4 Globe valves: Application: Throttling, flow control, emergency bypass:

.1 NPS 50 mm (2") and under:

.1 With PFTE disc, as specified. Bronze.

.2 NPS 65 mm (2 1/2") and over:

.1 With solid bronze disc, bronze trim, cast iron body.

.5 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, with chain and cap.

.6 Swing check valves:

.1 NPS 50 mm (2") and under:

.1 Class 150, swing, with PFTE disc, as specified. Bronze. Jenkins 4475TJ.

.2 NPS 65 mm (2 1/2") and over:

.1 Flanged or Grooved ends, Bronze trim, Cast Iron: Gate, Globe, Check.

.7 Ball valves:

.1 NPS 80 mm (3") 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:

.1 NPS 50 mm (2") and under screwed ends to ANSI B1.20.1 and with hex. shoulders.

.2 NPS 65 mm (2½") and over flanged or grooved ends.

.4 Stem: stainless steel tamperproof ball drive.

.5 Ball and seat: replaceable stainless steel solid ball and teflon seats.

.6 Operator: removable lever handle.

.7 Extended handles on chilled water valves.

.8 Full port.

.8 All valves shall be of commercial grade and of same manufacturer.

.9 Acceptable Manufacturers:

.1 Newman Hattersley Canada Ltd.

.2 Jenkins/Crane

.3 Milwaukee

.4 Toyo

.5 Kitz

2.3 BALANCING VALVES

.1 Size 15 mm (1/2") to 50mm (2"): Bronze body, brass ball, NPT connections and variable orifice.

.2 Size 65 mm (2 1/2") to larger: Cast iron body, raised flange connections, glove style with brass plug.

.3 Differential pressure readout ports with internal EPT inserts and check values, 6 mm (¼")NPT tapped drain/purge ports, memory stop and calibrated nameplate.

.4 Acceptable Manufacturers:

.1 Bell & Gossett Circuit Setters

.2 Armstrong

.3 Taco

.4 Tour & Anderson

.5 Oventrop

2.4 TRIPLE DUTY VALVE

.1 Straight pattern, combination check, throttling shut off and calibrated balancing valve, heavy duty cast iron construction with standard 125 psig ANSI flanged connections rated for maximum working pressure of 175 psig at 250ºF.

.2 Valve shall be fitted with a replaceable bronze disk with EPDM seat insert, stainless steel stem and chatter preventing spring. Valve design shall permit replacing under full system pressure.

.3 Valve shall be equipped with brass readout valves (with integral check valves).

.4 Acceptable Manufacturers:

.1 Bell & Gossett

.2 Armstrong

2.5 AUTOMATIC AIR VENT

.1 Industrial float vent: cast iron body and NPS 15 mm (1/2") connection and rated at 860 kpa (125 psi) working pressure.

.2 Float: solid material suitable for 115°C (240°F) working temperature.

.3 Plastic vents are not acceptable.

.4 Acceptable Manufacturers:

.1 Maid-O-Mist No. 67

.2 Spirax Sarco

Part 3 Execution

3.1 PIPING INSTALLATION

.1 Installation shall be by a licensed pipe fitter.

.2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.3 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.

.4 Slope piping in direction of drainage and for positive venting.

.5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.7 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.

.8 Assemble piping using fittings manufactured to ANSI standards.

.9 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

3.2 VALVE INSTALLATION

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

.2 Install butterfly valves on chilled water and condenser water lines only.

.3 Install gate or ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.4 Install globe valves for balancing and in by-pass around control valves as indicated.

.5 Provide silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

.6 Provide swing check valves in horizontal lines as indicated.

.7 Install chain operators on valves NPS 65 mm (2½") and over where installed more than 2400 mm (96") above floor in Boiler Rooms and Mechanical Equipment Rooms.

.8 Provide ball valves for glycol service.

3.3 AIR VENTS

.1 Install at high points of systems.

.2 Install ball valve on automatic air vent inlet.

.3 Extend vent lines in Mechanical Room with screwdriver stop at 1.8 m AFF.

3.4 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.1 On return side of all heating devices (convectors, panels, force flows, radiation, coils, etc.).

.2 On return side of all water or glycol cooling coils.

.3 On return side of all reverse return piping loops and/or branch circuits.

.2 Install to manufacturers requirements.

.3 Minimum valve size shall be one pipe size smaller than piping or 20 mm (¾"), whichever is larger.

.4 Refer to Testing Adjusting and Balancing Section for applicable procedures.

3.5 FILLING OF SYSTEM

.1 Refill system with clean water adding water treatment as specified.

.2 Co-ordinate filling of system with HVAC water treatment contractor.

.3 **Refill glycol heating system with 40% propylene glycol solution as specified.**

3.6 TESTING

.1 Test system in accordance with Mechanical General Requirements Section.

.2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair any leaking joints, fittings or valves.

3.7 GLYCOL CHARGING

.1 **Provide mixing tank and positive displacement pump for glycol charging.**

.2 **Retest for concentration to ASTM E202 after cleaning.**

.3 **Provide report to Consultant.**

.4 **Maintain glycol level in storage tank until system is fully charged and has equalized throughout the entire system. Monitor system on bi-weekly basis until system is completely filled. Provide glycol solution as required.**

3.8 FLUSHING AND CLEANING

.1 Scope:

.1 **Drain and flush entire existing system and new piping.**

.2 Refer to Water Treatment Section.

.3 Procedure:

.1 Flushing and cleaning should only take place after successful piping pressure testing.

.2 Terminal device (reheat coils, heat pumps, perimeter radiation, etc.), air handling unit coils and their associated control and balancing valves should be bypassed during the preliminary flushing and cleaning process.

.3 Instruments such as flow meters, flow metering valves and orifice plates should only be installed after flushing and cleaning.

.4 Timing:

.1 The overall construction schedule identifies piping flushing and cleaning with realistic time allotments.

.2 The mechanical contractor is required to provide a detailed report outlining the processes and procedures for flushing and cleaning per piping system at least 4 to 6 weeks in advance of work.

.3 As a minimum, at least one piping flushing and cleaning procedure shall be witnessed, by the consultant and/or commissioning agent.

.5 The mechanical contractor shall to utilize a qualified water treatment specialist to supervise the flushing and cleaning process and provide the certified water analysis report certifying that the piping systems are clean.

.6 Coordinate flushing and cleaning of mechanical systems with HVAC water treatment contractor and HVAC systems commissioning contractor.

.7 Flush and clean new piping system in presence of Consultant.

.8 Flush after pressure test for a minimum of 4 hrs.

.9 Fill system with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hrs.

.10 Thoroughly flush all new mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.

.11 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.

.12 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.

.13 Drainage to include drain valves, dirt pockets, strainers, every low point in system.

.14 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.15 Re-install strainer screens/baskets only after obtaining Consultant's approval and approval from HVAC water treatment contractor.

.16 Repeat system drain and flush as often as necessary to have a clean system.

.17 Disposal of cleaning solutions to be approved by authority having jurisdiction.

.18 Isolate new piping system from existing system as required for system cleaning.

.19 **After hydronic system is cleaned, refill with clean water and chemical as per chemical supplier treatment.**

.20 **After glycol piping system is cleaned, refill with 40% glycol solution.**

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 Canadian Standards Association (CSA).

.3 CAN/CSA-B214, Installation Code for Hydronic Heating Systems.

.4 American Society for Testing and Materials (ASTM).

.5 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.

.6 ASTM A48/A48M, Specification for Gray Iron Castings.

.7 ASTM A536, Specification for Ductile Iron Castings.

.8 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.

.9 American Society of Mechanical Engineers (ASME).

.10 ASME B16.1, Specification for Gray Iron Pipe Flanges and Flanged Fittings.

.11 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).

.12 Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.13 National Energy Code of Canada for Buildings (NECB).

.14 National Electrical Manufacturer's Association (NEMA)

.15 NEMA MG 1, Motors and Generators.

.16 American National Standards Institute/Hydraulics Institute (ANSI/HI)

.17 ANSI/HI 1.3, Rotodynamic (Centrifugal) Pumps for Design and Application.

.18 Pump manufacturer shall be ISO-9001 certified.

.19 Each pump shall be factory tested and name-plated before shipment.

.20 ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR).

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with General Requirements.

.2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, and controllers.

.3 Submit product data of pump curves for review showing point of operation.

.4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

1.3 MAINTENANCE DATA

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

Part 2 Products

2.1 IN-LINE CIRCULATORS

.1 Close-coupled, inline for vertical or horizontal installation, in cast iron bronze fitted (or all bronze) construction specifically designed for quiet operation.

.2 Pump internals shall be capable of being serviced without disturbing piping connections.

.3 Shaft: solid stainless steel that is integral to the motor.

.4 Motor bearings shall support the shaft via heavy-duty permanently lubricated ball bearings.

.5 Internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall be the unitized type with stainless steel drive tabs, EPR bellows and seat gasket, stainless steel spring, and be of a carbon silicon-carbide design with the carbon face rotating against a stationary silicon- carbide face. 300

.6 Pump shaft shall connect to a brass impeller. Impeller shall be hydraulically and dynamically balanced, threaded onto the motor shaft.

.7 Pump shall be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.

.8 Pump volute shall be of a cast iron design for heating systems. The connection style on the cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles.

.9 Motors shall meet scheduled horsepower, speed, and voltage. Motors shall have permanently lubricated ball bearings sized to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

.1 Motors up to 0.375 (½HP) shall be ODP, open drip proof.

.2 Motors above 0.375 (½HP) shall be TEFC, totally enclosed fan cooled.

.10 Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts. Press fit components shall not be permitted.

.11 Design Pressure & Temperature: Suitable standard operations at 225°F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F.

.12 Capacity: as indicated on schedules.

.13 Accessories:

.1 External mechanical seal flush line.

.14 Acceptable Manufacturers:

.1 Bell & Gossett Series

.2 Armstrong

2.2 VERTICAL IN-LINE CIRCULATORS (SPLIT-COUPLED)

Split-coupled, inline for vertical installation, in cast iron stainless steel fitted construction specifically designed for quiet operation.

.1 Pump internals shall be capable of being serviced without disturbing piping connections.

.2 Shaft: 416 stainless steel shaft that is guided by a carbon graphite lower throttle bushing.

.3 Pump shall be equipped with a unitized inside mechanical seal assembly with flush line. The seal assembly shall have an EPR elastomer bellows and a positive metal-to-metal drive system to reduce torsional stress on the bellows. The bellows will be pressure supported without creases or folds for long life. The mechanical seal shall have a rotating carbon face against a stationary ceramic face. (As an option, an outside mechanical seal may be used in lieu of the inside mechanical seal design. The outside seal materials shall be EPR elastomer with carbon-ceramic faces.)

.4 Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.-2016. The allowable residual imbalance conforms to ANSI grade G6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.

.5 The pump shall include a spacer coupling of high tensile aluminum, split to allow servicing of the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design.

.6 The combination motor bracket and volute coverplate shall be a one-piece unit to ensure concentric alignment of the motor to the pump casing. A carbon steel coupler guard shall be mounted on the motor bracket for safety.

.7 Pump volute shall be of a Class 30 cast iron design for heating systems. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.

.8 Motors shall meet scheduled horsepower, speed, and voltage. Motors shall have permanently lubricated ball bearings sized to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

.1 Motors shall be TEFC, totally enclosed fan cooled.

.9 Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts. Press fit components shall not be permitted.

.10 Design Pressure & Temperature: Suitable standard operations at 225°F and 175 PSIG working pressure for buildings up to six stories, and 250°F and 250 PSIG working pressures for building over six stories high.

Working pressures shall not be de-rated at temperatures up to 250°F.

.11 Capacity: as indicated on schedules.

.12 Accessories:

.1 Suction strainer.

.2 Triple duty valve.

.3 One mechanical seal for each model type of primary pump.

.4 Sediment separator shall be furnished for installation on the flushing line between the pump discharge flange and the seal area.

.13 Acceptable Manufacturers:

.1 Bell & Gossett Series

.2 Armstrong

.14 The seismic capability of the pump shall allow it to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.

2.3 SUCTION DIFFUSER

.1 Body: cast iron with flanged connections.

.2 Construction strainer: with built-in disposable construction 1.19 mm (3/64") mesh no. 16, low pressure drop screen (maximum 2 psig) and NPS 25 mm (1") blowdown connection.

.3 System strainer: Provide permanent 3.0 mm perforated stainless steel strainer (mesh no. 7) with maximum pressure drop of 1 psig.

.4 Permanent magnet particle trap.

.5 Full length straightening vanes.

.6 Pressure gauge tappings.

.7 Adjustable support leg.

.8 Angle orientation. Line size inlet and pump suction size outlet.

.9 Acceptable Manufacturer:

.1 To match pump supplier.

2.4 TRIPLE DUTY VALVES

.1 Body: Cast iron with flanged connections. Straight pattern combination shut off, non slam check and calibrated balance valve.

.2 Brass seat, bronze disk with EPDM seat insert.

.3 Brass stem, stainless steel spring, teflon-graphite packing.

.4 Brass readout valve.

.5 Straight orientation when installed in discharge piping downstream of pump. Line size inlet and outlet.

.6 Angle orientation when installed at pump outlet. Pump discharge size inlet and line size outlet.

.7 Acceptable Manufacturer:

.1 To match pump supplier.

2.5 SPARE PARTS

.1 Refer to Section 23 05 11 General HVAC Work Requirements.

.2 One spare mechanical seal for each model type for primary pump.

.3 Two (2) spare filter cartridges for each pump.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment in accordance with manufacturer's instructions.

.2 Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

.3 Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.

.4 On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.

.5 All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

.6 On components that require draining, contractor must provide piping to and discharging into appropriate drains.

.7 Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable codes.

.8 Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable codes.

.9 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible suction discharge in vertical alignment.

.10 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.11 Pipe drain tapping to floor drain complete with isolating valve.

.12 Install volute venting pet cock in accessible location.

.13 Check rotation prior to start-up.

.14 Install pressure gauge with plug cocks on inlet and outlet on pump.

3.2 SUCTION DIFFUSERS

.1 Install on inlet to pumps.

.3 Clean hydronic system with both strainers installed (mesh 16 and mech 17).

.4 Remove construction screen strainer (mesh 16) from inlet suction guide after system cleaned and before balancing. Mount mesh 16 strainer on wall for future cleaning use

3.3 TRIPLE DUTY VALVES

.1 Valves shall be straight pattern.

.2 Provide 4x pipe diameter spool piece between pump discharge and triple duty valve.

.3 Leave valves open for TAB to set.

3.4 PUMP VIBRATION

.1 Install pumps isolated from the piping system when larger than 2" piping main.

.2 Install pumps on vibration isolators and flex connectors when greater than 3.0 HP.

.3 Install pumps on an inertia pad when on an upper floor level and 3.0 HP or greater. Pumps mounted on slab, on grade, for 3.0 HP or greater can be on spring isolator base.

.4 All pumps 15 HP and greater shall be installed on inertia base regardless of location in building.

3.5 SENSORLESS PUMP COMMISSIONING

.1 This contractor shall arrange for pump manufacturer's representative, TAB contractor, BAS contractor, and mechanical contractor to be present for all equipment start-up and commissioning.

.2 Manufacturer's representative shall complete full start-up of all sensorless pumps.

.3 Record all pump setpoints (including those provided via the TAB contractor for head pressure) and submit start-up data as part of pump maintenance manuals.

.4 Verify in writing pump modulation has been tested and working correctly based on system requirements.

3.6 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ANSI/ASME B16.22, Wrought Copper Alloy and Copper Alloy Solder - Joint Pressure Fittings: Classes 150, 300, 600, 900, 1500, and 2500.

.3 ANSI/ASME B16.24, Cast Copper Pipe Flanges and Flanged Fittings.

.4 ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

.5 ANSI/ASME B31.5, Refrigeration Piping and Heating Transfer Components.

.6 ASTM A307, Specification for Carbon Steel Bolts and Studs, 413.5 mPa (60,000 psi) Tensile Strength.

.7 ASTM B280, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.8 CSA B52, Mechanical Refrigeration Code.

.9 EPS 1/RA/2, Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

- .1 Hard copper: to ASTM B280, Type ACR-B.
- .2 Soft copper: to ASTM B280, Type ACR
- .3 Refer to Part 3 for allowed applications.

2.2 FITTINGS

.1 Service: design pressure 2070 kPa (300 psi) and temperature 121°C (250°F).

.2 Brazed:

- .1 Fittings: wrought copper to ANSI/ASME B16.22.
- .2 Joints: silver solder, 45% Ag-15% Cu or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:

- .1 Bronze or brass, to ANSI/ASME B16.24, Class 150 and Class 300.
- .2 Gaskets: suitable for service.
- .3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

- .1 Bronze or brass, for refrigeration, to ANSI/ASME 16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm (1/4") clearance all around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm (7/8") and under: Class 500, 3.5 MPa (500 psi), globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm (7/8"): Class 375, 2.5 MPa (375 psi), globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

2.5 FILTER-DRIER

.1 On lines 20 mm (3/4") outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.

.2 On lines smaller than 20 mm (3/4") outside diameter, filter-drier shall be sealed type using flared copper fittings.

.3 Size shall be full line size.

.4 Acceptable Manufacturers:

.1 Mueller

.2 Parker

.3 Sporlan

.4 Virginia

2.6 SIGHT GLASS

.1 Combination moisture and liquid indicator with protection cap.

.2 Sight glass shall be full line size.

.3 Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.

.4 Acceptable Manufacturers:

.1 Mueller

.2 Henry

.3 Parker

.4 Superior

2.7 SUCTION LINE TRAP

.1 Manufactured standard one-piece traps.

2.8 EXPANSION VALVES

.1 For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.

.2 Size valves to provide full rated capacity of cooling coil served. Co-ordinate selection with evaporator coil and condensing unit.

.3 Acceptable Manufacturers:

.1 Henry

.2 Mueller

.3 Parker

.4 Sporlan

2.9 FLEXIBLE CONNECTORS

.1 Designed for refrigerant service with bronze seamless corrugated hose and bronze braiding.

.2 Approved Manufacturers:

.1 Anaconda “Vibration Eliminators” by Anamet

.2 Vibration Absorber Model VAF by Packless Industries

.3 Vibration Absorbers by Superior Valve Co

.4 Style “BF” Spring-flex freon connectors by Vibration Mountings.

2.10 ROOF FLASHING

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

2.11 PIPING SUPPORT ASSEMBLY

.1 All channel members shall be fabricated from structural grade steel conforming to one of the following ASTM specifications: A1011/A1011M, A653/A653M.

.2 All fittings shall be fabricated from steel conforming to one of the following ASTM specifications: A575, A36/A36M or A635/A635M.

.3 Electro galvanized cush clamps with shoulder bolt and molded thermoplastic cushion, size to suit pipe.

.4 Acceptable Manufacturers:

.1 Unistrut

.2 Or equal

Part 3 Execution

3.1 GENERAL

.1 Install in accordance with CSA B52, EPS 1/RA/2 and ANSI/ASME B31.5.

.2 Connect to equipment with isolating valves and unions.

.3 Provide space for servicing, disassemble, and removal of equipment and components all as recommended by manufacturer.

.4 Protect all openings in piping against entry of foreign material.

.5 Provide all necessary equipment including thermal expansion valve, sight glass, solenoid valve, filter dryer, etc., for a complete installed system. Pipe system as per manufacturer's recommendation and requirements.

.6 Provide number of refrigerant circuits and appropriate corresponding piping as per manufacturer's recommendations and requirements.

3.2 APPLICATION

.1 Hard copper shall be used as follows:

.1 For all other systems/applications.

.2 For all exterior piping.

3.3 PIPING THROUGH FLOORS

.1 Refrigerant piping systems containing refrigerants that pass through floors not served by the system shall be installed as per the requirements of CSA B23-2023:

.1 Refrigerant piping shall be installed through a rigid and tight, continuous fire-resisting pipe (stainless steel, cast iron or similar) without openings into any floors not served by the system.

.2 The pipe shall be vented to the floor served by the system.

.3 Soft copper may be used when the shaft extends beyond two (2) storeys in length.

3.4 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.5 PIPING INSTALLATION

.1 General:

.1 Hard drawn copper tubing: do not bend. Minimize use of fittings.

.2 Soft drawn copper: install in a neat manner without excessive bends or twists. Minimize use of fittings.

.3 Fittings, joints and other connections to equipment shall be minimized in all inaccessible areas, including but not limited to areas above drywall ceilings, shafts etc.

.4 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.

.5 Provide trap at base of risers greater than 2.4m (8') high and at each 7.6m (25'-0") thereafter.

.6 Provide inverted deep trap at top of each riser.

.7 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified above.

.2 Small riser: size for 5.1 m/s (1000 ft/min) at minimum load. Connect upstream of traps on large riser.

3.6 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2 MPa (290 psi) and 1 MPa (145 psi) on high and low sides respectively.

.3 Test Procedure: Build pressure up to 35 kPa (5 psi) with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

.4 Testing shall be completed to the standards of CSA B52, section 5.10 so that the exemption contained in Annex N (N.1.2) allowing areas (such as those above fully enclosed drywall ceilings) to have joints and connections installed within them is met.

3.7 DEHYDRATION AND CHARGING

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13°C (55°F) for at least 12 h before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use 2-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa (0.02" WC) absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate all system components containing gases other than correct refrigerant or having lost holding charge as follows:

.1 Twice to 14 Pa (0.056" WC) absolute and hold for 4 h.

.2 Break vacuum with refrigerant to 14 kPa (0.056" WC).

.3 Final to 5 Pa (0.02" WC) absolute and hold for at least 12 h.

.4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.

.5 Submit all test results to Consultant.

.7 Charging:

.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.

.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make all checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report all measurements to Consultant.

3.8 INSTRUCTIONS

.1 Post instructions in frame with glass cover in accordance with Operation and Maintenance Manual Section and CSA B52.

3.9 PREFABRICATED PIPE CHASE

.1 Install on prefabricated, insulated roof curb.

.2 Install pipe chase and pipe entry to manufacturers installation instructions.

.3 Provide field installed insulation on roof deck to match roof insulation thickness.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Plumbing Specialties and Accessories.

.2 Hydronic Systems – Steel.

1.2 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 American Society of Mechanical Engineers (ASME).

.3 ANSI/ASME Boiler and Pressure Vessel Code, Section VI.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for incorporation into manual specified in general requirements

.2 Include following:

.1 Log sheets as recommended by manufacturer.

.2 Test reports.

Part 2 Products

2.1 MANUFACTURER

.1 Equipment, chemicals, service by one supplier.

.2 Acceptable manufacturer:

Chem-Aqua

Vanessa Vautour, 416-428- 7940, vanessa.vautor@nch.com

Tricia Bloomfield, 905-457-5220 ext 318, tricia.bloomfield@nch.com

2.2 POT FEEDER

.1 Welded steel, pressure rating 1200 kPa (175 psi). Temperature rating: 90°C (194°F).

2.3 WATER TREATMENT FOR HYDRONIC SYSTEMS

.1 Hot water heating system: Pot feeder, 19 l (5 gal).

.2 Chilled water system: Pot feeder.

.3 Glycol chilled water system: Pot feeder.

.4 Glycol system: Pot feeder.

.5 Ten (10) Micron filter for each pot feeder:

.1 Capacity 2% of pump recirculating rate at operating pressure.

.2 Six (6) sets of filter cartridges for each type, size of micron filter.

.6 Balancing valve set for 2% pump capacity.

2.4 GLYCOL HEATING FEED SYSTEM (GLYCOL CHILLED SIMILAR)

.1 Glycol feed system:

.1 200 litre polyethylene 40% polypropylene glycol solution holding tank complete with suction strainer and shut-off valve on a painted blue, angle iron steel stand.

.2 Rotary bronze gear pump 1/3 HP, 2.0 USGPM @75 psi maximum 120 V/1/60 differential pressure (.25 kW, 7.5 l/min @ 517 kPa) with built-in relief valve.

.3 Low-level float switch, audible alarm and light.

.4 Adjustable pressure switch 10-150 psi (100-1000 kPa) range.

.5 Prewired, tank mounted control panel including the following:

.1 Power On switch and status lights

.2 Hand-Off-Auto selection switch

.3 Pump S.P. S. T. relay

.4 Terminal Strip

.5 NEMA 1 enclosure

.2 Hydronic System: Pot Feeder 25L

.3 Micron filter for pot feeder:

.1 Capacity 2% of pump recirculating rate at operating pressure.

.2 Six (6) sets of filter cartridges for each type, size of micron filter.

.4 Balancing valve set for 2% pump capacity.

.5 Glycol solution shall be Dowfrost HD inhibited propylene glycol based fluid as manufactured by Dow Chemical. Temperature range (-50°F to 325°F).

2.5 CHEMICALS

.1 Provide 1 year’s supply.

2.6 TEST EQUIPMENT

.1 Provide one set of test equipment for each system to verify performance.

.2 Complete with carrying case, reagents for chemicals, all specialized or supplementary equipment.

2.7 CLEANING CHEMICALS

.1 Provide as required to make system clean.

.2 Cleaner chemical: compatible and of the same manufacturer of the water treatment supplier.

2.8 RECORD MANAGEMENT

.1 Provide cards and card holder mounted on wall adjacent to each pot feeder.

Part 3 Execution

3.1 INSTALLATION

.1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.2 CHEMICAL FEED PIPING

.1 Install crosses at all changes in direction. Install plugs in all unused connections.

3.3 WATER TREATMENT SERVICES

.1 After entire new and existing system is cleaned as specified elsewhere, provide monthly water treatment monitoring and consulting services for period of one year after system start-up. Provide written report to consultant after each visit. Service to include:

.1 Initial water analysis and treatment recommendations.

.2 System start-up assistance.

.3 On site system testing and recording of treated hydronic system.

.4 Operating staff training.

.5 Visit plant every 7 days during first month of operation and as required until system stabilizes and advise consultant in writing on treatment system performance.

.6 Provide monthly visits with reports after system has stabilized to the satisfaction of the owner.

.7 Provide necessary monthly recording charts and log sheets for one year operation.

.8 Provide necessary laboratory and technical assistance.

.9 Instructions and advice to operating staff to be clear, concise and in writing.

3.4 START-UP

.1 Start up water treatment systems in accordance with manufacturer's instructions.

3.5 SYSTEM COMMISSIONING AND TRAINING

.1 Commissioning and training shall be provided by installing water treatment sub-contractor and water treatment supplier.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After start-up and before TAB of connected systems.

.3 Pre-commissioning Inspections:

.1 Verify:

.1 Presence of test equipment, reagents, chemicals, details of specific tests to be performed, operating instructions.

.2 Suitability of log book.

.3 Currency and accuracy of initial water analysis.

.4 Required quality of treated water.

.4 Commissioning procedures - applicable to all Water Treatment Systems:

.1 Establish, adjust as necessary and record all automatic controls and chemical feed rates.

.2 Monitor performance continuously during commissioning of all connected systems and until acceptance of project.

.3 Establish test intervals, regeneration intervals.

.4 Record on approved report forms all commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.

.5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.

.6 Visit project at monthly intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).

.7 Advise Engineer in writing on all matters regarding installed water treatment systems.

.5 Commissioning procedures - Closed Circuit Hydronic Systems:

.1 Analyse water in system.

.2 Based upon an assumed rate of loss approved by Engineer, establish rate of chemical feed.

.3 Record types, quantities of chemicals applied.

.4 Provide written verification of glycol solution concentration.

.6 Training:

.1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

.2 Train O&M personnel in softener regeneration procedures.

.7 Certificates:

.1 Upon completion, furnish certificates confirming satisfactory installation and performance.

.8 Commissioning Reports:

.1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, all other data required by Consultant.

.9 Commissioning activities during Warranty Period:

.1 Check out water treatment systems on regular basis and submit written report to Consultant.

3.6 CLEANING OF MECHANICAL SYSTEM

.1 Coordinate cleaning of mechanical systems with mechanical contractor.

.2 Provide copy of recommended cleaning procedures and chemicals for approval by Consultant.

.3 Procedure:

.1 Flushing and cleaning should only take place after successful piping pressure testing.

.2 Terminal device (reheat coils, heat pumps, perimeter radiation, heat exchangers etc.), air handling unit coils and their associated control and balancing valves should be bypassed during the preliminary flushing and cleaning process.

.3 Instruments such as flow meters; flow metering valves and orifice plates should only be installed after flushing and cleaning.

.4 Timing:

.1 The overall construction schedule identifies piping flushing and cleaning with realistic time allotments.

.2 The mechanical contractor is required to provide a detailed report outlining the processes and procedures for flushing and cleaning per piping system at least 4 to 6 weeks in advance of work.

.3 As a minimum, at least one piping flushing and cleaning procedure shall be witnessed, by the consultant and/or commissioning agent.

.5 The mechanical contractor shall to utilize a qualified water treatment specialist to supervise the flushing and cleaning process and provide the certified water analysis report certifying that the piping systems are clean.

.6 Coordinate flushing and cleaning of mechanical systems with HVAC water treatment contractor.

.7 Flush and clean new piping system in presence of Owner

.8 Flush after pressure test for a minimum of 4 hrs.

.9 Fill system with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hrs.

.10 Thoroughly flush all new mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.

.11 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.

.12 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.

.13 Drainage to include drain valves, dirt pockets, strainers, every low point in system.

.14 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.15 Reinstall strainer screens/baskets only after obtaining Owner's approval and approval from HVAC water treatment contractor and board chemical treatment technician.

.16 Repeat system drain and flush as often as necessary to have a clean system.

.17 Disposal of cleaning solutions to be approved by authority having jurisdiction.

.18 Isolate new piping system from existing system as required for system cleaning.

3.7 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.

.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
Square and Rectangular			
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
Round and Oval			
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
Residential Suite Ductwork:			
Square and Rectangular			
Up to 300 mm (12") *	26	26	26
Round and Oval Snap Lock *			
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 Nexas 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 45º entry on branch.

.2 Round main and branch: enter main duct at 45º 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 90º round spin in collars with balancing damper and locking quadrant.

.6 Transitions:

.1 Diverging: 20º maximum included angle.

.2 Converging: 30º 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 KITCHEN EXHAUST SYSTEMS

.1 Construct in accordance with ANSI/NFPA 96.

.2 Material: Type 316 stainless steel sheet or carbon steel.

.3 Clearance: 450 mm (18") to combustible materials or protected to NFPA 96 requirements.

.4 Fabrication: as indicated.

2.10 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Dishwasher exhaust.

.2 Fresh air intake.

.3 Minimum 3000 mm (120") from duct mounted humidifier in all directions.

.4 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer.

2.11 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.

Trapeze hangers: ducts over 500 mm (20") diameter or longest side, to ASHRAE and SMACNA.

.2 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)

.3 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
Science Room Exhaust	+/-	A	Stainless steel
Dryer Exhaust	+	A	Aluminum
Shower Exhaust	+	A	Aluminum
Exhaust Plenum	+	A	Galvanized steel
HVAC Supply and Return	+/-	B	Galvanized steel
General Exhaust	-	B	Galvanized steel
Shower Exhaust	-	B	Aluminum
Ventilation Plenum	+/-	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 mm (")	Spacing 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 WATERTIGHT DUCT

.1 Slope horizontal branch ductwork down towards hoods served. Slope header ducts down toward risers.

.2 Fit base of riser with 150 mm (6") deep drain sump and 25 mm (1") drain connected, with deep seal trap and valve and discharging to open funnel drain.

3.4 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.

3.5 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 then 3 branch takeoffs and two 90º 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).

3.6 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.

3.7 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 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 ASTM C423, Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.4 ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.5 ASTM E477, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Provide separate shop drawings for each piece of attenuation equipment complete with product data.

1.3 PERFORMANCE RATING DATA

.1 Provide performance rating data, certified by an accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:

.1 Silencer: insertion loss, pressure drop at design conditions, generated noise level.

.2 Acoustic plenums: transmission loss and acoustical absorption.

Part 2 Products

2.1 ABSORPTION AND INSULATING MEDIA

.1 Acoustical performance measurements to be made in accordance with ASTM E477, ASTM E90 and ASTM C423, except where specified otherwise.

.2 Acoustic quality, glass fibre, free of shot and odor; bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

2.2 ACOUSTIC SOUND PLENUMS

.1 Panels: 50 mm thick tongue and groove connection type, designed for individual panel removal for equipment access without major dismantling of plenum.

.1 Outer sheet: 1.3 mm (18 gauge) thick galvanized steel to ASTM A526/A526M, with coating designation Z90.

.2 Inner sheet: 0.085 mm (4 mil) thick galvanized steel to ASTM A526/A526M, with coating designation Z90 with 2 mm (79 mil) diameter clean cut perforations on 5 mm (3/16") staggered centres.

.3 Fully framed with 1.3 mm (18 gauge) thick galvanized steel channels.

.4 Horizontal stiffeners: 0.85 mm (22 gauge) minimum galvanized steel on 800 mm (32") centres to control media settlement.

.5 Deflection: not to exceed 1/240 of unsupported panel span at design pressure differential of 2500 Pa (10" w.c.).

.6 Connections: as per manufacturers requirements.

.2 Assembly:

.1 Panel and flashing joints externally sealed with 6 mm (1/4") diameter bead of non sag, non hardening sealant. Floor channel to floor connection sealed with 3 mm x 15 mm (1/8" x 1/2") monolastomeric tape.

.2 Factory cut and frame openings where greatest dimension exceeds 300 mm (12"). Smaller panel openings, to be site located and cut 50 mm (2") larger in diameter, sleeved with 0.7 mm (22 gauge) minimum galvanized steel.

.3 Fill space between pipe or conduit and sleeve with acoustic media, covered and mastic sealed in accordance with manufacturer's instructions.

.4 No sensory leakage at design pressure differential of 1000 KPa (145 psi).

.5 Assembly RSI not less than 1.2 m2°C/W (6.81 ft2°F/Btuh) at 10°C (50°F).

.3 Acceptable Manufacturers:

.1 BVA Systems

.2 Vibron

.3 VAW Systems

.4 IAC Acoustics

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Noise flanking: where indicated, install in wall sleeve with uniform clearance all around to ensure no contact of silencer with wall sleeve. Pack with flexible, non hardening caulking on both sides of sleeves.

.3 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.

.4 Suspension: to manufacturer's instructions.

3.2 SITE VISIT

.1 Supplier of equipment to visit site to ensure installation is in accordance with manufacturer's instructions and submit report to Consultant

.2 Make adjustments and corrections in accordance with written report.

.3 Provide Consultant with notice 48h in advance of visit.

3.3 TESTING

.1 Experienced and competent sound and vibration testing professional engineer to take sound measurement after start up and testing, adjusting and balancing of systems to Testing Adjusting and Balancing (TAB) of Mechanical Systems section.

.2 Sound measurements to extend over specified frequency range of 250 to 2000 and to be taken:

.1 Upstream and downstream of each silencer and plenum.

.2 In areas adjacent to mechanical equipment rooms, duct and pipe shafts.

.3 At 1800 mm (72") above floor adjacent to first air terminal.

.3 Provide Consultant with notice 48 h in advance of commencement of tests.

.4 Establish adequacy of equipment isolation, acceptability of noise levels in occupied areas, other conditions affecting acoustics and, where appropriate, recommendation for remedial measures and costs.

.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 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 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (25 gauge) thick complete with sheet metal angle frame.

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

.3 Gaskets: neoprene

.4 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.

.5 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 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 and viewing panels:

.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 SPLITTER DAMPERS

.1 Of same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Double thickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 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.

2.4 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

2.5 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

2.6 VOLUME EXTRACTORS

.1 Fully adjustable gang operated blade volume extractor.

.2 Cold rolled steel construction, 25 mm (1") blade spacing with matte black finish.

.3 Provide Type 1 manual adjusting operating lever.

.4 Acceptable Manufacturers:

.1 EH Price AE-1

.2 Krueger EX8/EX88

.3 Or equal approved by consultant

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 VOLUME EXTRACTOR

.1 Install at branch take off connections where indicated.

.2 Secure lever adjustment rod to inside duct collar after final adjustments.

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.

.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 (STATIC)

.1 Fire dampers: arrangement as indicated, listed and bear label of ULC, meet requirements of provincial fire authority and authorities having jurisdiction. Fire damper assemblies to be fire tested in accordance with CAN/ULC-S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.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 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 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.

.6 Acceptable Manufacturers:

.1 Ruskin
.2 Nailor
.3 E.H. Price
.4 T.A. Morrison
.5 Tamco
.6 Ventex/Alumavent
.7 United Enertech
.8 Safeair-Dowco (stainless steel)
.9 Greenheck
.10 Pottorff

2.2 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

2.3 MULTIBLADE DAMPERS (DYNAMIC OR STATIC)

.1 Provide and install multiblade dampers where roll type fire dampers do not have a ULC listing for the size of the penetration through the assembly.

.2 Multi blade type fire dampers shall be suitable for HVAC system velocities up to 2000 fpm (610 m/mm), dual direction air flow, max 4" wg pressure.

.3 Damper shall be labelled for dynamic or static systems as appropriate for the installed location.

.4 Frame shall be constructed on 16 ga (1.6) steel hat channel with mitered corners reinforced with die-formed corner gussets for strength.

.5 Damper blades shall be 14 ga (2.0) equivalent steel formed double skin, airfoil design.

.6 Damper shall be of opposed blade configuration with an interlocking blade design. Blade seals are not acceptable.

.7 Blade axels shall be double bolted at each end of the blade to provide positive locking connection.

.8 Bearings shall be sintered stainless steel type.

.9 Blade linkage shall be zero-maintenance, concealed in frame and out of the air stream.

.10 Each damper shall be complete with a UL listed fusible link that will cause the damper to close and lock in closed position by means of an over centre/knee lock linkage for assured closure.

.11 Each damper shall be provided with an internal manual locking quadrant(s) for setting and locking of blades in desired position.

.12 Provide a steel sleeve of appropriate gauge and length for the assembly being penetrated.

.13 Provide a 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.

.14 Fire damper assemblies and type to meet requirements of provincial fire authority and authority having jurisdiction.

.15 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.

.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 ACCEPTABLE MANUFACTURERS

.1 Damper:

.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)

2.2 SMOKE DAMPERS

.1 Provide a complete system, consisting of the damper, damper actuator, 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.

.1 The smoke detector shall be supplied and installed under the electrical division.

.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

.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.

.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 The smoke detector shall be supplied and installed under the electrical division.

.2 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 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 Size: as indicated on drawings.

.10 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 COMBINATION FIRE AND SMOKE DAMPERS

.1 Provide a complete system, consisting of the damper, damper actuator, 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.

.1 The smoke detector shall be supplied and installed under the electrical division.

.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.

.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 The smoke detector shall be supplied and installed under the electrical division.

.2 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 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).

2.4 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.

2.5 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.

2.6 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. Coordinate with electrical trade on site.

.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. Coordinate with electrical trade on site.

2.7 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/ft2 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 CLEANING

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

3.6 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.

3.7 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 DISC TYPE DAMPERS

.1 Frame: brake formed, welded, 1.6 mm (16 gauge) thick, Type Z90 galvanized steel to ASTM A653/A653M.

.2 Disc: spin formed, 1.6 mm (16 gauge) thick, Type Z90 galvanized steel to ASTM A653/A653M.

.3 Gasket: extruded neoprene, field replaceable.

.4 Bearings: roller self lubricated and sealed.

.5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.

.6 Performance:

.1 Leakage: in closed position to be less than 0.001% of rated air flow at 100 kPa (15 psi) pressure differential across damper.

.2 Pressure drop: at full open position to be less than 100 kPa (15 psi) differential across damper.

.7 Acceptable Manufacturers:

.1 Duro Dyne

.2 Henderson Industrial

.3 Pottorff

2.3 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

2.4 RELIEF DAMPERS

.1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights 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 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 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 ASTM C423, Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.4 ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.5 ASTM E477, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Provide separate shop drawings for each piece of attenuation equipment complete with product data.

1.3 PERFORMANCE RATING DATA

.1 Provide performance rating data, certified by an accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:

.1 Silencer: insertion loss, pressure drop at design conditions, generated noise level.

.2 Acoustic plenums: transmission loss and acoustical absorption.

Part 2 Products

2.1 ABSORPTION AND INSULATING MEDIA

.1 Acoustical performance measurements to be made in accordance with ASTM E477, ASTM E90 and ASTM C423, except where specified otherwise.

.2 Acoustic quality, glass fibre, free of shot and odor; bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

2.2 SILENCERS

.1 Silencer type as indicated.

.2 Factory manufactured of prime coated or galvanized steel, compatible with ductwork specified elsewhere and to ASHRAE and SMACNA standards.

.3 Outer casing and galvanized steel inner casing with clean cut circular perforations to enclose acoustic media. Inner casing to have half-splitters running full length of silencer where any cross sectional dimension exceeds 450 mm (18"). Protect media from erosion with glass fibre cloth between media and perforated metal.

.4 Confirm silencer is proper type for system. Silencer to be sized for 35DB in occupied space.

.5 Manufacturer shall confirm silencer(s) selection is based on sound power levels of equipment to be silenced. Indicate sound power levels of equipment on silencer shop drawings.

.6 Acceptable Manufacturers:

.1 Vibro – Acoustics

.2 BVA Systems

.3 Vibron

.4 VAW Systems

.5 IAC Acoustics

.6 EH Price

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Noise flanking: where indicated, install in wall sleeve with uniform clearance all around to ensure no contact of silencer with wall sleeve. Pack with flexible, non hardening caulking on both sides of sleeves.

.3 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.

.4 Suspension: to manufacturer's instructions.

3.2 SITE VISIT

.1 Supplier of equipment to visit site to ensure installation is in accordance with manufacturer's instructions and submit report to Consultant

.2 Make adjustments and corrections in accordance with written report.

.3 Provide Consultant with notice 48h in advance of visit.

3.3 TESTING

.1 Experienced and competent sound and vibration testing professional engineer to take sound measurement after start up and testing, adjusting and balancing of systems to Testing Adjusting and Balancing (TAB) of Mechanical Systems section.

.2 Sound measurements to extend over specified frequency range of 250 to 2000 and to be taken:

.1 Upstream and downstream of each silencer and plenum.

.2 In areas adjacent to mechanical equipment rooms, duct and pipe shafts.

.3 At 1800 mm (72") above floor adjacent to first air terminal.

.3 Provide Consultant with notice 48 h in advance of commencement of tests.

.4 Establish adequacy of equipment isolation, acceptability of noise levels in occupied areas, other conditions affecting acoustics and, where appropriate, recommendation for remedial measures and costs.

.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 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 –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.

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.

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^3 (6 lb/ft^3).

2.2 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

2.3 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

2.4 JOINT TAPE

.1 Poly-Vinyl treated open weave fiberglass membrane 50 mm (2") wide.

.2 Acceptable Manufacturers:

.1 Duro Dyne FT2

.2 Ductmate

2.5 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 (-90F) 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 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 gasketted aluminum backdraft dampers.
.6 Disconnect switch within fan housing.
.7 Continuous curb gaskets, cadium 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.

2.3 CABINET FANS – IN-LINE

.1 Fan characteristics and construction: As centrifugal fans.

.2 Casing floor mounted or cabinet hung single inlet aluminum wheel in factory fabricated casing complete with vibration isolators and seismic control measures, motor, V-belt drive and guard inside or outside casing as indicated.

.3 Fabricate casing of zinc coated or phosphate treated steel reinforced and braced for rigidity. Provide removable panels for access to interior. Uncoated, steel parts shall be painted over with corrosion resistant paint to CAN/CGSB 1.181. Internally line cabinet with 25 mm (1") thick rigid acoustic insulation, pinned and cemented bell mouth inlet cone.

.4 Size, type, and capacity: As 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 RANGE HOOD EXHAUST FANS

.1 Centrifugal direct drive 750 mm (30") wide, suitable for under cabinet installation, enamel steel metal housing complete with halogen lights, colour selected by Consultant.

.2 Sizes and capacity: As indicated.

.3 Internal Toggle switch operated fan and light.

.4 Top or rear side 80 mm x 250 mm (3" x 10") rectangular duct outlet with integral backdraft damper.

.5 Wall cap complete with spring loaded backdraft damper with neoprene gasket.

.6 Aluminum mesh cleanable grease filter.

2.6 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 gasketted 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

.5 Prohibited/Non-Allowed Manufacturers: Plastech

2.7 DRYER BOOSTER FAN (RESIDENTIAL)

.1 Provide a fully automatic dryer booster fan where indicated.

.2 Provide a Fantech DBLT or equal 100 mm (4") paintable galvanized lint trap complete with removable filter and 15 mm flange for flush mounting.

.3 Fan shall be inline complete with low profile, self cleaning backward inclined impeller and high efficiency meter suitable for 120/1/60.

.4 Provide a current sensing relays in electrical junction box on the power feed to the dryer to operate the dryer booster fan in sequence. Dryer and power relay to be ORTECH Amp Sensor Model as without time delay or equal. Co-ordinate installation with the electrical contractor, providing power to the dryer.

.5 All wiring shall be by Electrical Division.

.6 Acceptable Manufacturer:

.1 Reversomatic ‘TLD’ Series with DAS 200 sensor.

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 WORK INCLUDED

.1 The ceiling mounted, circulation fan as indicated on drawings. The fan shall be the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware and variable speed controls.

1.2 RELATED WORK

.1 Factory installation services are available through the manufacturer, consult the appropriate installation scope of work for more information.

Part 2 Products

2.1 HIGH VOLUME, LOW SPEED FANS – BIG ASS FANS POWERFOIL D MODEL

.1 Complete Unit:
The fan shall be ETL certified and built pursuant to construction guidelines set forth by UL standard 507 and CSA standard 22.2. The fan shall be designed to move an effective amount of air for cooling and destratification in large industrial applications with dense floor obstructions, over an extended life. The fan and components shall be designed specifically for high volume, low speed fans to ensure lower noise operation. The sound levels from the fan operating at maximum speed shall not exceed 55 dBA (measured 20'or 6.1 m below the blades and 20'or 6.1 m horizontally from the center of the fan).

.2 Airfoils:
The fan shall be equipped with ten (10) high volume, low speed airfoils of precision extruded aluminum alloy. Each airfoil shall be of the high performance Powerfoil design. The airfoils shall be connected by means of two (2) locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers. Airfoils to be powder coated as specified by the architect (provide 1 special colour).

.3 Winglets:
The fan shall be equipped with ten (10) Powerfoil Plus winglets designed to move air away from the fan at an angle, thereby increasing the amount of area affected by the fan. The winglets shall be molded of high density polyethylene. A winglet shall be attached at the tip of each airfoil by means of a barrel screw. Winglets to be powder coated as specified by the architect (provide 1 special colour).

.4 Motor:
The fan motor shall be an AC induction type inverter rated at 1725 RPM, 208 VAC, 1 ϕ and 60 Hz. The motor shall be totally enclosed, fan cooled (TEFC) with an IP55 NEMA classification. NEMA standard frames 56C/143TC/145TC shall be provided for ease of service. The motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in -30°F to 122°F (-34°C to 50°C) ambient conditions.

.5 Gearbox:
The fan gearbox shall be a NitroSeal™ Drive designed specifically for the Powerfoil X. The gearbox shall include a high efficiency, hermetically sealed, nitrogen filled, offset helical gear reducer with two stage gearing, a 2-1/2" (6.4 cm) hollow output shaft, cast iron housing, double lip seals, high quality SKF Explorer Series bearings with crowned cages for optimal lubrication flow, and precision machined gearing to maintain backlash less than 11 arc minutes over the life of the unit. Lubrication shall be a high grade, low foaming synthetic oil with extreme pressure additives and a wide temperature range.

The fan gearbox shall be equipped with a passageway in which wiring, piping, etc can be routed below the fan. A non-rotating, standard junction box shall be provided at the base of the fan for installing optional features such as lights, cameras, and VESDA. An aluminum cover plate shall be provided for attachment to the junction box when these features are not installed.

.6 Mounting Post:
The fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and upper mounting system. The mounting post shall be 3"x 3" (7.6 cm x 7.6 cm) square tubing and powder coated for corrosion resistance and appearance. Mounting post to be powder coated as specified by the architect (provide 1 special colour).

.7 Hub:
The fan hub shall be precision cast aluminum alloy for high strength and light weight. The hub shall be secured to the output shaft of the gearbox by means of a steel flange interface. Both hub and flange shall be precision machined to achieve a well balanced and solid rotating assembly. The hub shall incorporate five (5) safety retaining clips made of 1/4" (0.6 cm) thick steel that shall restrain the hub/airfoil assembly in case of gearbox output shaft failure.

.8 Mounting System:
The fan mounting system shall be designed for quick and secure installation from a structural support beam. All components in the mounting system shall be of welded construction using low carbon steel no less than 3/16" (0.5 cm) thick and be powder coated for appearance and resistance to corrosion. All mounting bolts shall be SAE Grade 8 or equivalent and rated with a minimum tensile strength of 150,000 psi (1,034 MPa). Mounting components to be powder coated as specified by the architect (provide 1 special colour).

.9 Safety Cable:
The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 3/8" (1 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel. The loops shall be secured with swaged Nicopress fittings, pre-loaded and tested to 3,000 lb f (13,345 N). Field construction of safety cables is not permitted.

.10 Controller:
The fan controller shall be constructed using a Variable Speed Drive (VSD) that is prewired to the motor and factory programmed to minimize the starting and braking torques, for smooth and efficient operation. The controller shall be prewired to the motor using a short fun of flexible conduit THHM with a dedicated ground conductor to minimize electromagnetic interference (EMI) and radio frequency interference (RFI). An incoming power cord shall also be prewired to the controller for ease of installation. The controller shall be contained within a completely sealed aluminum enclosure and secured to the mounting post “onboard” the fan assembly.

.11 Wall Control:
The fan shall be equipped with a remote wall control. The wall control shall be a digital keypad device mounted inside an aluminum bezel. The bezel shall be capable of mounting to a standard wall box. The wall control shall be equipped with touchpad controls and an LED display for controlling the fan’s direction, operation and speed. Communication with the fan drive and controller shall be by a standard commercially available CAT-5 (or higher) Ethernet cable that is field installed and provided by the installer. A 5’ (1.5 m) ‘patch cable’ shall be provided to test and verify communication signals locally prior to connecting the remote connection cable.

The wall control shall be equipped with a simple diagnostic program to identify faults in the system. Provisions must be made for retrieving fan operation and diagnostic data (fault messages) through the remote wall device.

.12 Warranty: Refer to Part 3 Section.

.13 Capacity:

- As indicated.

.14 Acceptable Manufacturer:

Basco Canada

Phone: (416) 770-0047

Contact: Patrick Wilson

Email: patrick.wilson@bigasssolutions.com

Part 3 Execution

3.1 INSTALLATION

.1 The fan shall be mounted to an angle iron or I-beam structure. Consult the Installation Guide for proper sizing and placement of angle iron for a span mount. A structural engineer must be consulted for installation methods outside the manufacturer’s recommendation and a certification submitted prior to installation.

.2 To reduce the risk of injury to persons, the fan shall be installed so that the airfoils are at least 10’ (3 m) above the floor. The fan installation area must be free of obstructions such as lights, cables, sprinklers or other building structures; with the airfoils at least 2’ (61 cm) clear of all obstructions. The fan should not be installed where it will be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems.

.3 If the fan is hung from an extension tube that measures 4' (1.2 m) or longer, it may be necessary to provide guy cables or struts to limit potential lateral movement of the fan. A stiffening strut braced against an additional beam may be required if there is a close clearance situation.

.4 The design criteria for the fan mounting system shall be capable of handling 300 ft lbs (407 N m) of torque.

.5 **Fan shall be shut down thru the fire alarm system.**

3.2 WORKMANSHIP

.1 Good workmanship shall be evident in all aspects of construction. Field balancing of the airfoils shall not be necessary.

3.3 DOCUMENTATION

.1 The manufacturer shall furnish a copy of all operating and maintenance instructions for the fan.

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.

.2 High Volume, Low Speed Fans – Big Ass Fans Powerfoil X Plus Model

.1 The manufacturer shall replace any products or components defective in material or workmanship, free of charge to the customer (including transportation charges within the USA, F.O.B. Lexington, KY), pursuant to the complete terms and conditions of the Big Ass Fans Non-Prorated Warranty in accordance to the following schedule:

.1	Airfoils	Lifetime (Parts)
.2	Hub	Lifetime (Parts)
.3	Motor	Ten (10) years (Parts)†
.4	Gearbox	Ten (10) years (Parts)†
.5	Controller	Ten (10) years (Parts)†
.6	Labor	One (1) year††

† 10 year parts warranty only valid with factory installation, 5 year parts without factory installation.

†† All reasonable costs of repair or replacement will be paid or reimbursed provided customer obtains pre-approval; see full warranty for details.

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 **All variable volume air boxes are to be provided in their oversized/large capacity version to limit pressure drop across the heating coil**.

.3 The assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume.

.4 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.).

.5 Sound ratings of air distribution assemblies, shall not exceed 30 NC at 25 Pa (0.10" w.c.) static pressure.

.6 Pressure shall be ARI Certified.

.7 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.

.8 Provide a discharge air temperature sensor on discharge of VAV box. Temperature sensor shall be capable of display on BAS.

.9 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.

.10 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.

.11 Provide 900 mm (36") long discharge sound attenuator for each unit.

.12 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.

.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

2.2 CONSTANT VOLUME BYPASS BOXES

.1 Maintains space condition by bypassing supply air to return air.

.2 Sizes, capacities, pressure loss as indicated.

.3 Complete with:

- .1 Bypass collar for connection to return air duct.
- .2 Minimum air volume stop.
- .3 Controller and operator.
- .4 Reheat coil as indicated.
- .5 Manual balancing damper.

.6 Multi-port outlets as indicated.

.7 Discharge silencer as indicated.

.4 Casing: constructed of 0.7 mm (22 gauge) thick galvanized steel, internally lined with 25 mm (1"), 0.7 kg/m2 (0.14 lb/ft2) density fibrous glass, to UL 181 and ANSI/NFPA 90A. Mount control components inside protective metal shroud.

.5 Damper: galvanized steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa (3" w.c.) inlet static pressure, in accordance with Air Diffusion Council test procedure.

.6 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.

.7 Damper actuator shall accept a low voltage, digital, input signal from the associated HVAC unit's refrigeration detection system. On receipt of the signal the damper shall fully open. The damper position shall reset upon stop of the signal.

.8 Acceptable Manufacturers:

.1 EH Price

.2 Titus

.3 Barber Colman

.4 Carnes

.5 Nailor

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 Type, size, and capacity: as indicated.

2.3 RETURN AND EXHAUST GRILLES

.1 Type, size, and capacity: as indicated.

2.4 DIFFUSERS

.1 General: flow straightening devices

.2 Type, size, and capacity: as indicated.

2.5 TOE SPACE GRILLE

.1 Punched steel at 25 mm x 2 5mm (1" x 1") spacing with 15 m x 15 m (1/2" x 1/2") hole.

.2 Screw fastening and finish selected by consultant.

.3 Type, size and capacity: as indicated.

.4 Colour: to Consultant's approval

2.6 OPEN MESH SCREEN

.1 15 mm x 15 mm (½" x ½") open mesh screen fastened on 25 mm (1") border, screw fasten.

.2 On all open ends of ductwork and where indicated.

.3 Size: To match ductwork size.

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 GOOSENECK HOODS

.1 Thickness: to ASHRAE and SMACNA.

.2 Fabrication: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA and or proprietary manufactured duct joint.

.1 Acceptable Manufacturers:

.1 Ductmate Canada

.2 Exanno Nexus

.4 Supports: as indicated.

.5 Complete with integral birdscreen of 2.7 mm (12 gauge) diameter aluminum wire. Use 15 mm (1/2") mesh on exhaust 20 mm (3/4") mesh on intake.

.6 Vertical or Horizontal backdraft dampers as required.

.7 Prefabricated roof curb through roof complete with insulation and counter flashing.

2.2 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

2.3 BRICK VENTS (FLANGE FRAME)

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern.

.4 Perimeter flange frame, head, sill and jamb: 40 mm (1½") deep one piece extruded aluminum, minimum 3 mm (1/8") thick with approved caulking slot, integral to unit.

.5 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.

.6 Screen: 15 mm (1/2") exhaust 20 mm (3/4") exhaust mesh, 2 mm (5/64") diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.7 Finish:

.1 Powder coated.

.2 Colour: to Consultant's approval.

.8 Options:

.1 Straight duct extension.

.2 Perimeter flange frame.

.9 Acceptable Manufacturers:

.1 Greenheck Model BVF

.2 Construction Specialties

.3 E.H. Price

.4 Krueger

.5 Ruskin

.6 Ventmaster

.7 Ventex

.8 Nailor

2.4 THIN LINE 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 Perimeter flange frame, head, sill and jamb: 50 mm (2") deep one piece extruded aluminum, minimum 3 mm (1/8") thick with approved caulking slot, integral to unit

.5 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.

.6 Screen: 20 mm (3/4"), 2 mm (5/64") diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.7 Finish:

.1 Powder coated.

.2 Colour: to Consultant's approval.

.8 Acceptable Manufacturers:

.1 Greenheck ESJ-150

.2 Construction Specialties

.3 E.H. Price

.4 Krueger

.5 Ruskin

.6 Ventmaster

.7 Nailor

.8 Ventex

2.5 ALUMINUM WALL CAPS (CLOTHES DRYER)

.1 Application: Clothes dryer or as noted on drawings.

.2 0.3 mm (16 gauge) aluminum wall sleeve sized as noted on plans.

.3 0.3 mm (16 gauge) sloping exterior wall cap with integral sides, base plate, and 25 mm (1") perimeter flange with 4-hole screw fasten. Fasteners at each corner.

.4 Bottom outlet with removable 15 mm x 15 mm (1/2") x (1/2") aluminum screen.

.5 Neoprene backdraft damper with aluminum crimp on bottom edge.

.6 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 PRODUCT DATA

.1 Submit product data in accordance with general requirements.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Clearly indicate following:

- .1 Methods of sealing sections.
- .2 Methods of expansion.
- .3 Details of thimbles.
- .4 Bases/Foundations.
- .5 Supports.
- .6 Guy details.
- .7 Velocity Cone.

.3 Venting manufacturer shall provide shop drawings for review based on boiler model and capacity, height, offset and termination location. Submit venting calculations certified by the boiler manufacturer.

1.3 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for incorporation into manual specified in general requirements.

1.4 CERTIFICATIONS

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

Part 2 Products

2.1 POSITIVE PRESSURE VENTING (CATEGORY III AND IV)

.1 The vent shall be of the double wall, factory-built type, designed for use in conjunction with Category III, or IV condensing or non-condensing positive pressure appliances or as specified by the heating equipment manufacturer.

.2 Maximum continuous flue gas temperature shall not exceed 550˚F (288˚C).

.3 Vent shall be listed for a maximum positive pressure rating of 6.0" w.c. and shall have passed testing at 15.0" w.c.

.4 The vent system shall be continuous from the appliance’s flue outlet to the vent termination outside the building. All systems components shall be ULC listed and supplied by the same manufacturer.

.5 The vent shall be constructed with an inner and outer tube, with an annular space between the tubes of 25 mm (1").

.6 The inner tube (flue gas conduit) shall be constructed from AL29 4C® or UNS S44735 stainless steel, with a min. wall thickness of 0.4 mil (26 ga) for 3" through 7" diameter vents, 0.5 mil (24 ga) for 8" through 12" diameter vents and 0.6 mil (22 ga) for 14" and 16" diameter vents.

.7 The outer tube (jacket) shall be constructed from 304 or 430 stainless steel, with a minimum wall thickness of 0.4 mil (26 ga) for 3" through 6" diameter vents and 0.6 mil (22 ga) for 7" through 16" diameter vents.

.8 All systems components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be UL listed and provided by the vent manufacturer.

.9 All system components shall include a factory-installed gasket in their female-end to render the vent air and water tight when the male/female ends are pushed together as per manufacturer's instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.

.10 All systems components shall include a factory installed, internal mechanical locking band for fastening and securing all vent components against each other.

.11 Vent layout shall be designed and installed in compliance with manufacturer's installation instructions boiler manufacturer, and all applicable local codes.

.12 Acceptable Manufacturers:

.1 Pro Tech Systems, Inc. – FasNSeal W2 (Insulated)

.2 Van Packer

.3 Z-Flex Model SVE-IV (Insulated)

.4 Cheminée Lining

.5 Selkirk/Ampco

.6 Security Chimneys International

.7 ICC Chimney VIP

2.2 TYPE A GAS VENT

.1 ULC labelled, 537º C (1000º F) rating maximum, atmospheric gas vent only.

.2 Sectional, prefabricated, double wall with 50 mm (2") insulated cavity. Stainless steel inner wall. Stainless steel outer wall. Mated fittings and couplings.

2.3 ACCESSORIES

.1 Cleanouts: bolted, gasketted type, full size of breeching, as indicated.

.2 Barometric dampers: double acting, 70% of full size of breeching area.

.3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA)

.4 Velocity Cone.

.5 Expansion sleeves with heat resistant caulking, held in place as indicated.

.6 Roof flashing cones.

.7 Guy wire supports and anchors.

Part 3 Execution

3.1 INSTALLATION – GENERAL

.1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

.2 Suspend breeching at 1.5 m (5') centres and at each joint.

.3 Support chimneys at bottom, roof and intermediate levels as indicated.

.4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.

.5 Install flashings on chimneys penetrating roofs and building structures.

.6 Install velocity cones and cleanouts, as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 Canadian Standards Association (CSA).

.1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

.3 Canadian Gas Association (CGA).

.1 CAN1-3.1, Industrial and Commercial Gas-Fired Package Boilers.

.2 CSA-B149.1, Natural Gas and Propane Installation Code.

.4 American National Standards Institute (ANSI).

.1 ANSI Z21.13, Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.5 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV.

.6 ASHRAE 90.1 – Energy Standard for Building Except Low-Rise Residential Buildings

1.2 BOILER SYSTEM LAYOUT ON FLOOR

.1 Pre-planning of the boiler room system must be done prior to any new construction in the boiler room beginning. The contractor shall provide a full-scale markup of the boiler system on the floor of the boiler room. The markup shall be in various coloured chalk and shall include all the components/equipment of the boiler system.

.1 Housekeeping pad sizes/locations.

.2 Floor/hub drain locations.

.3 Vent/chimney stack locations and locations thru roof.

.4 Boiler positions (including burner & front door swing – depending on type of boiler).

.5 Rough locations and routing for heating supply/return headers and branch piping.

.6 Location of gas train (compared to boiler access/door swing) so gas can be disconnected from one or two unions.

.7 Locations for pumps, air separator, sink, eyewash, expansion tanks, etc.

.8 Locations for chemical treatment pot feeder assembly and makeup water assembly.

.9 Coordinate with the electrician and include markup locations for starters, panels, VFDs, etc.

.10 Location of unistrut supports where needed to route wiring or mount piping or equipment.

.11 Location of BAS controls & panels.

.2 Markup shall be reviewed with the consultant and owner prior to new installations starting. Changes or adjustments of the layout will be made with chalk during the review.

.3 Contractor to provide multiple photos of the final chalk layout.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Indicate the following:

.1 Capacities of selected model

.2 General arrangement showing terminal points, instrumentation test connections.

.3 Clearances for operation, maintenance, servicing, cleaning.

.4 Piping hook-ups.

.5 Equipment electrical drawings.

.6 Burners and controls.

.7 All miscellaneous equipment.

.8 Flame safety control system.

.9 Breeching and stack configuration.

.10 Warranty information

.3 Engineering data to include:

.1 Boiler efficiency at 100% of design capacity.

.2 Radiant heat loss at 100% design capacity.

.3 Water side pressure drop curve

.4 Certificate of Product Rating: AHRI Certificate indicating Thermal Efficiency, Combustion Efficiency, Materials of Construction, Input and Gross Output

1.4 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for incorporation into manual specified in general requirements.

1.5 CERTIFICATION

.1 Manufacturer's Certification: The boiler manufacturer shall certify the following:

.1 The products and systems furnished are in strict compliance with the specifications.

.2 the boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.

.3 ASME certification.

.4 CSA (AGA/CGA) certification.

.5 The specified factory tests have been satisfactorily performed.

.6 The equipment furnished contains inter-changeable parts with the specified equipment so that all major equipment parts can be obtained from the specified manufacturer.

Part 2 Products

2.1 GENERAL

.1 Furnish the number of factory "packaged" low pressure hot water boilers indicated on the drawings. Each factory "packaged" boiler shall be complete with all components, accessories, and appurtenances necessary for a complete and operable boiler as hereinafter specified. Each unit shall be furnished factory assembled with required wiring and piping as a self-contained unit. Each unit shall be readily transported and ready for installation.

.2 Each hot water boiler shall consist of a vertical, stainless steel heat exchanger complete with trim, valve trains, burner, and boiler control system. The boiler manufacturer shall fully coordinate the boiler as to the interaction of its elements with the burner and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.

.3 The boiler manufacturer shall provide unit responsibility for the engineering, coordination, workmanship, performance, warranties, and all field services for each factory "packaged" boiler as specified herein. The boiler manufacturer shall be fully responsible for all components assembled and furnished by him whether or not they are of his own manufacture.

2.2 PERFORMANCE CRITERIA

.1 Refer to schedules for boiler capacities.

.2 Boiler shall be capable of operating with a minimum outlet water temperature of 20°C (68°F).

.3 Boiler shall comply with ASME Section IV for 345 kPa (50 psig) (max 98°C/200ºF).

.4 Boiler relief valve setting shall be 345 kPa (50 psig) max.

.5 Maximum allowable water temperature shall be 210°F

.6 Fuel shall be natural gas with an assumed higher heating value of 1,030 Btu/Cu Ft and an assumed specific gravity of 0.60 (relative to air). Natural gas shall be supplied at a pressure of no less than 3.5” w.c. to the inlet gas valve. Maximum inlet gas pressure shall not exceed 14” w.c.

.7 Ambient air temperature shall be assumed to range from 10°C (50°F) to 32°C (90°F) with an average of 21°C (70°F).

.8 Power voltage shall be 120/208 vac, 1-phase, 60 hertz. Control voltage shall be 24 vac (transformer to be supplied by boiler manufacturer).

.9 Boiler shall be suitable for use with either water or glycol solutions.

2.3 HEAT EXCHANGER

.1 Each boiler heat exchanger shall be duplex stainless steel, single or multi-pass, down fire, counter-flow design for maximum heat transfer with the multiple sections arranged in a reverse return configuration to assure balanced flow through each section

.2 Boiler heat exchanger headers shall be fabricated stainless steel and be completely removable for inspection. Seals shall be EPDM, rated for 400°F service. Push nipples or gaskets between the sections are not permitted.

.3 Heat exchange capability shall be maximized through the use of a corrugation process or fins.

2.4 PRESSURE VESSEL

.1 Shall be constructed of carbon stainless steel with welded heads and tube connections.

.2 Pressure vessel shall be counter-flow design for water flow, with internal water baffling plates if required to meet energy efficiency requirements.

.3 The water volume of the boiler shall not be less than 42 gallons of water volume/1000 MBH.

.4 The pressure vessel shall have sufficient water capacity to be flow tolerant without minimum flow requirements or the use of a flow switch.

The allowable pressure drop across the boiler inlet and outlet connections shall not exceed **2.0 psi/4.6 ft H20** if the system is piped as a primary flow only.

2.5 FRAME AND ENCLOSURE

.1 Boiler shall be enclosed with a single wall outer casing. It shall be fabricated from a minimum 16 gauge carbon steel. The complete outer casing shall be finished, inside and out, with a powder coat finish.

.2 The composite structure of the boiler combustion chamber, insulating air gap and outer casing shall be of such thickness and materials to assure an outer casing temperature of not more than 37°C (100°F) when the boiler is operated at full rated load.

.3 An observation port shall be located on the boiler to allow for observation of the burner flame.

.4 Access panels shall be hinged.

.5 Provide appropriate NEMA 250, Type 1 enclosure for controls components.

.6 Provide lifting eyes and fork holes accessible for rigging and movement of the boiler.

.7 Minimum 2" thick insulation surrounding the heat exchanger.

2.6 CONNECTIONS

.1 Each boiler shall be provided with all necessary inlet and outlet connections. Boiler connections shall be as follows:

.1 One (1) water supply outlet, Victaulic

.2 One (1) water return inlet, Victaulic

.3 One (1) relief valve outlet.

.4 One (1) flue gas vent outlet.

.5 One (1) fuel gas inlet.

.6 A flue gas outlet shall be located on the rear of the boiler. Boiler to be certified for installation with Category IV venting (stack) as defined in NFPA 54 (ANSI Z221), latest edition. Contractor must provide venting (stack) certified for installation on a Category IV appliance.

2.7 MAIN GAS VALVE TRAIN (MODULATING)

.1 Each boiler shall be provided with an integral main gas valve train. The main gas valve trains shall be factory assembled, piped, and wired. Each gas valve train shall include at least the following:

.1 One (1) manual shutoff valve (gas train inlet connection).

.2 Two (2) safety shutoff valves. Valves equipped with dual solenoids that can independently energized for leak testing.

.3 Modulating Air – Gas ratio control (maximum inlet pressure 14" w.c.).

.4 One (1) low gas pressure switch (manual reset).

.5 One (1) high gas pressure switch (manual reset).

.6 Two (2) pressure test ports.

.7 Union connection to permit burner servicing.

2.8 NEUTRALIZING VESSEL

.1 Rotationally molded low density polyethylene vessel with minimum 3" diameter fill/access openings at each end, 3/4" diameter inlet and outlet pipe connections. Provide all necessary mounting hardware. Unit (or units if more than 1 is required) is to be sized to neutralize capacity of condensate from boiler, before being drained to sewer system. Vessel to be sized to suit condensate produced by the boiler.

.2 Provide initial charge of limestone and store one (1) additional charge where directed on site.

.3 Acceptable Manufacturers: From boiler manufacturer.

2.9 IGNITION SYSTEM

.1 Each boiler shall be equipped for direct spark ignition.

2.10 COMBUSTION AIR CONTROL SYSTEM (DIGITAL)

.1 Each boiler shall be provided with an integral combustion air control system. The combustion air system shall be factory assembled. Each combustion air control system shall include at least the following:

.1 The primary control shall vary the speed of the blower based on load demand. The blower shall apply a varying negative pressure on the gas valve, which will open or close to maintain zero pressure at the valve orifice, thereby increasing or decreasing the firing rate. Both the air and gas shall be premixed in the blower.

.2 One (1) low airflow differential pressure switch to insure that combustion air is supplied.

.3 High exhaust back pressure switch.

2.11 VENTING

.1 The boiler shall be capable of operating with a stack effect not exceeding -0.04" W.C. and a combined air intake and exhaust venting pressure drop not exceeding +1.50" W.C.

.2 It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors, or by drawing air from the mechanical space itself.

.1 Sealed Combustion: Contractor shall supply and install venting to suit manufacturers installation guidelines.

.2 Mechanical Space: Manufacturer shall supply and install filter for combustion air intake if required or recommended by manufacturer.

.3 Flue Gas exhaust stack shall be AL 29-4C, 316L stainless steel or other material as indicated in manufacturer installation manual. Material shall be listed and labelled to UL 1738 / C0UL S636 for use with Category IV appliances. Material shall be guaranteed appropriate for the application by the manufacturer of the boiler.

.4 Condensate drain material must be stainless steel or Schedule 40 CPVC. Copper, carbon steel, or PVC pipe materials are not acceptable.

2.12 CONTROL PANEL

.1 The boiler manufacturer shall provide each boiler with an integral factory prewired control panel. The control panel shall contain at least the following components, all prewired to a numbered terminal strip:

.1 One (1) burner "on-off" switch.

.2 One (1) electronic combination temperature control, flame safeguard and system control.

.3 Control circuit breaker, 5 amp.

.4 All necessary control switches, pushbuttons, relays, timers, terminal strips, etc.

2.13 INTERNAL CONTROL

.1 Boiler control system shall consist of an integral boiler display and micro-processor control system.

.2 LED Display Panel to adjust set points and control operating parameters. LED display to indicate burner sequence, all service codes (0-65), fan speed, boiler set point, sensor values such as inlet, outlet, flue gas and outdoor air.

.3 Control system shall be capable of controlling/staging multiple boiler systems, as well as starting/stopping primary boiler pumps, varying primary pump speed based on boiler firing rate and opening and closing the boiler automatic isolation valve. Boiler shall be able to control minimum two separate heating loops.

.4 In a multiple boiler system, the control shall stage and modulate the boilers utilizing firing rate threshold staging and parallel modulation to optimize condensing potential while minimizing energy wasting short cycling. The control shall monitor the supply water temperature and return water temperature and communicate between the boilers on a local boiler system control network.

.5 Boiler controls shall have provisions for outside air reset and night setback. Boiler manufacturer to provide outdoor air temperature sensor.

.6 All parameters shall be adjustable through the control panel display.

.7 Boiler control panels shall be mounted and located on the boiler to provide ease of servicing and prevent accidental water damage.

.8 The integral controller on each boiler shall provide for the following functions:

.1 Flame safeguard

.2 Burner sequencing, with safe start check, pre-purge, electronic direct spark ignition and post-purge. Combustion shall be proven.

.3 Flame Supervision: Maintain a running history of operating hours, number of cycles, and the most recent lockouts. Display information on display screen in clear English text descriptions without the need to look up error codes.

.4 Safety Shutdown with display of lockout and hold condition.

.5 PID modulating control of the variable speed fan for firing capacity relative to load requirements. i.e. to meet supply water temperature set point.

.6 Gas Pressure supervision (high and low)

.7 Combustion Air Proving supervision

.8 High Air Pressure (Back draft too high) supervision

.9 Control relay for operation of the isolation valve.

.10 Low Water Cut Off (provide for field installation if not integral to boiler)

2.14 BAS HARDWIRE INTEGRATION

.1 Terminal Strip Integration: Boiler shall communicate with the BAS via a terminal strip integration. Provide the following points for integration:

.1 Boiler Enable/Disable

.2 Boiler Status

.3 Boiler Alarm

.4 Hot Water Supply and Return Water Temperature Set Point

.5 Boiler modulation rate

.6 Firing Rate feedback

2.15 BACNET INTEGRATION

.1 The boiler shall also include for the addition of the BACNet integration.

.2 Through digital integration the following minimal information shall be controlled and visible:

.1 Writeable Points

.1 Hot Water Supply Temperature Set Point

.2 Hot Water Return Temperature Set Point

.3 Fire rate

.4 System/Boiler Pump Command

.5 Boiler Enable/Disable

.6 Lead/Lag Control (enable and settings)

.7 Emergency Shut down

.2 Readable Points

.1 Hot Water Supply Temperature

.2 Hot Water Return Temperature

.3 Fire Rate Feedback

.4 Failure/Alarm

.5 Cycle/Run Time totals

.6 Flow verification (if equipped with internal flow switch)

.7 Pump status

.8 Combustion efficiency

.9 Various operating status' as available in standard BACNet integration offering

.3 Lock out and error codes shall be transmitted to the BAS and be readable at the Operator Workstation so that error codes can be remotely accessed and reviewed prior to site visit. Manufacturer shall provide correct controller to provide this functionality.

2.16 ELECTRICAL CONNECTION

.1 Provide single point field power connection, factory installed and wired, including all transformers, control/safety devices and other devices as required for a complete and operable system.

.2 Power shall be 120 V, 60 Hz, single phase. Maximum 20 Amp breaker.

2.17 TRIM

.1 Boiler shall be provided with all necessary trim. Boiler trim shall be as follows:

.1 Safety relief valve shall be provided in compliance with the ASME code. Contractor to pipe to acceptable drain.

.2 Water pressure temperature gauge.

.3 Primary low water flow fuel cutoff (probe type with manual reset).

.4 High limit water temperature controller to stop burner operation at excess water temperature (shall be manual reset).

.5 Operating temperature control to control the sequential operation of the burner.

.6 Separate inlet and outlet water temperature sensors capable of monitoring flow.

.7 Alarm lights and horn

.8 LCD Display and Diagnostics

.9 Strainer in piping system ahead of each boiler.

2.18 ACCESSORIES

.1 Condensate neutralizing system

.2 Drain Valve

.3 Flow Switch (if required for boiler operation or indicated on plans)

.4 BACNet integration card and any required protocol translators for boiler integration with the Building Management System.

.5 Auto restart (on loss of power).

.6 Internal On/Off/Auto switch.

.1 Auto for BAS control.

.2 On for manual operation of boiler, with internal safeties and temperature setpoint.

2.19 ACCEPTABLE MANUFACTURERS

.1 PK Storm.

.2 Lochinvar Crest

Part 3 Execution

3.1 INSTALLATION

.1 Contractor shall install boilers in accordance with all manufacturer installation instructions and as indicated on the drawings.

.2 Meet all local and applicable codes of installation.

.3 Maintain manufacturer's recommended service clearances on all sides of the equipment.

.4 Supplying contractor shall install all shipped loose equipment.

.5 Supplying contractor shall be responsible for all interconnecting electrical control and power wiring, including high voltage wiring between boiler and isolation valve actuator.

.6 Install boilers on cast-in-place concrete housekeeping pads.

.7 Provide strainers on the inlet water piping.

3.2 QUALITY CONTROL

.1 Boiler shall be provided by a firm regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels, whose products have been in satisfactory use in service for not less than ten (10) years.

.2 Each factory “packaged” boiler shall be hydrostatically tested and bear the ASME “H” stamp.

.3 Each factory "packaged" boiler shall be fire tested. The boiler manufacturer shall perform this fire test under simulated operating conditions, with the boiler attached to a working chimney system and with water circulating through the boiler. The manufacturer shall provide a fire test report, including fuel and air settings and combustion test results permanently affixed to the boiler.

.4 The manufacturer shall have a factory authorized service training program, where boiler technicians can attend a training class and obtain certification to perform start-up, maintenance and basic troubleshooting specific to the product line. There shall be a minimum of 4 trained technicians within 100 km of the job site.

.5 Provided equipment shall be of the type, design and size that the manufacturer currently offers for sale and must appear in the manufacturer’s current catalogue.

3.3 FIELD TESTING

.1 The boiler manufacturer shall field test the following:

.1 Boiler and burner interlocks.
.2 Valves.
.3 Controllers.
.4 Gauges.
.5 Thermometers.
.6 Alarms
.7 Stack Pressure
.8 Switches.
.9 LCD Screen Functional Test
.10 Isolation Valve Actuators.
.11 Any malfunctioning component shall be replaced.

3.4 COMMISSIONING

.1 Manufacturer to:

.1 Certify installation.
.2 Start up and commission installation.
.3 Carry out on-site performance verification tests.
.4 Demonstrate operation and maintenance.

.2 Provide Consultant at least 48h notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.5 DEMONSTRATION AND TRAINING

.1 Provide minimum 2 hours training to owner's representative, including all safety procedures, maintenance procedures, control operations and diagnostic procedures.

.2 Training shall be provided by a factory trained service technician.

.3 Training shall occur at the installed location.

3.6 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 Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within the specified period:

.1 Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to thermal shock, flue gas condensate corrosion, and/or defective material or workmanship for a period of 10 years, non-prorated, from the date of Ready for Takeover provided the boiler is installed, controlled, operated, and maintained in accordance with the Installation, Operation and Maintenance Manual.

.2 Burner: The boiler manufacturer shall warranty the burner against defective material or workmanship for a period of five (5) years, non-prorated, from the date of Ready for Takeover.

.3 All other Components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material within twelve (12) months from the date of Ready for Takeover.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 All codes, standards, etc. as referenced shall be the latest edition.

.2 ANSI/ASME Boiler and Pressure Vessel Code, Section VIII Pressure Vessels.

.3 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

.4 AHRI Standard Certification

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with General Requirements.

.2 Indicate: manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.

1.3 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with General Requirements.

.2 Supply following spare parts:

.1 Head gaskets.

1.4 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in General Requirements.

Part 2 Products

2.1 PLATE HEAT EXCHANGER

.1 General:

.1 Fluids: As indicated

.2 Designed, constructed, and tested in accordance with ANSI/ASME Boiler and Pressure Vessel Code, Section VIII, CSA B51 and provincial pressure vessel regulations.

.2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts, and shroud.

.3 Plates: Type 316 stainless steel.

.4 Gaskets: 21.7 (150 lb).

.5 Nozzles: ASA rubber rated flange type.

.6 Supports: as indicated.

.7 Piping connections: 100 mm (4").

.8 Capacity:

.1 Primary water: as indicated in schedule on drawings.

.2 Secondary: as indicated in schedule on drawings.

.3 Working pressure: 175 psig or higher.

.4 Heat exchanged capacity: as indicated in schedule on drawings.

.9 Acceptable Manufacturers:

.1 Bell & Gossett

.2 Armstrong

.3 Alfa Laval

2.2 SPARE PARTS

.1 Refer to Section 20 05 11 Mechanical Work Requirements.

Part 3 Execution

3.1 INSTALLATION

.1 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.

.2 Tube in shell heat exchangers: arrange piping so that tube bundle can be removed after disconnecting two unions or flanges adjacent to head and without disturbing other equipment and systems.

.3 Arrange plate heat exchangers so they can be serviced, i.e. taken apart, cleaned, and new gaskets installed.

.4 Brazed plate and coaxial heat exchangers are not cleanable, so the strainer mounted ahead of these devices is very important, including the proper mesh strainer.

.5 Provide strainers ahead of all heat exchangers.

.6 Strainer mesh shall be selected to be only 75% size of the smallest opening in plate exchanger or less as recommended by the manufacturer.

.7 Consult heat exchanger manufacture for strainer sizing and provide as recommended.

3.2 APPURTENANCES

.1 Install with safety relief valve piped to drain hose bib drain valve.

.2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.

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.

.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-550/590, Performance Rating of Water Chilling Packages using Vapour Compression Cycle.

.3 CSA B52, Mechanical Refrigeration Code.

.4 ASTM C553, Mineral Fiber Blanket, Thermal Insulation for Commercial and Industrial Applications.

.5 EPS 1/RA/2, Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.2 SHOP DRAWINGS

.1 Submit an electronic copy of the shop drawings.

.2 Indicate:

.1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.

.2 Wiring as assembled and schematically.

.3 Dimensions, construction details, recommended installation, and support, mounting bolt hole sizes and locations and point loads.

.4 Type of refrigerant used.

1.3 MAINTENANCE AND ENGINEERING DATA

.1 Provide operation and maintenance data for incorporation into maintenance manuals.

.2 Data to include:

.1 Description of equipment giving manufacturers name, type, model year, capacity, and serial numbers.

.2 Provide part load performance curves.

.3 Details on operation, servicing, and maintenance.

.4 Recommended spare parts list.

1.4 START UP, COMMISSIONING, AND TRAINING

.1 Manufacturer to provide start up and commissioning of unit.

.2 Submit start up reports and data sheet for incorporation with maintenance manuals.

.3 Train owner and staff in the operation and maintenance of the equipment and system.

Part 2 Products

2.1 GENERAL

.1 Provide complete air cooled chiller package including: compressor; evaporator; condenser, motor and motor starter; controls; control centre; piping; wiring; refrigeration and oil charge; ready for connection to chilled water circuit, and electric power source, installed in welded steel frame with heavy gauge panels and access doors finished to manufacturers standard.

.2 Acceptable Manufacturers:

.1 Carrier

.2 Daikon

.3 Must have “Shell & Tube” heat exchanger.

2.2 CAPACITY

.1 Capacity: As indicated in schedule on drawings.

2.3 EQUIPMENT

.1 General:

Factory assembled, single-piece or factory-matched duplex chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge, and special features required prior to field start-up.

.2 Materials of Construction:

.1 The base rail is industrial-quality, 7ga, zinc-dipped, galvanized frame (with Magni-coated screws).

.2 Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish. 3. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (American Society for Testing and Materials) (U.S.A.) B-117 standard.

.3 Fans:

.1 Condenser fans shall be direct-driven (VFD [variable frequency drive] controlled on units with Greenspeed intelligence), 9-blade airfoil cross-section, reinforced polymer construction, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.

.2 The variable speed drives for the condenser fans on 30RB units with Greenspeed intelligence shall include a DC link reactor.

.3 Air shall be discharged vertically upward.

.4 Fans shall be protected by coated steel wire safety guards.

.4 Compressor/Compressor Assembly:

.1 Fully hermetic scroll type compressors.

.2 Direct drive, 3500 rpm (60 Hz), protected by motor temperature sensors, suction gas cooled motor.

.3 External vibration isolation rubber-in-shear.

.4 Each compressor shall be equipped with crankcase heaters to minimize oil dilution.

.5 Cooler:

.1 Shell-and-tube type, direct expansion.

.2 Tubes shall be internally enhanced seamless-copper type rolled into tube sheets.

.3 Shall be equipped with Victaulic-type water connections.

.4 Shell shall be insulated with 3/4". (19 mm) PVC foam (closed-cell) with a maximum K factor of 0.28.

.5 Design shall incorporate a minimum of 2 independent direct-expansion refrigerant circuits.

.6 Cooler shall be tested and stamped in accordance with ASME Code for a refrigerant working side pressure of 445 psig (3068 kPa). Cooler shall have a maximum water-side pressure of 300 psig (2068 kPa).

.7 Cooler shall be provided with a factory-installed flow switch.

.6 Condenser:

.1 Coil shall be air-cooled Novation® heat exchanger technology with microchannel (MCHX) coils and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a corrosion-resistant coating.

.2 Tubes shall be cleaned, dehydrated, and sealed.

.3 Assembled condenser coils shall be leak tested and pressure tested at 656 psig (4522 kPa).

.7 Refrigeration Components:

.1 Refrigerant circuit components shall include replaceable-core filter drier, moisture indicating sight glass, electronic expansion device, discharge service valve and liquid line service valves, and complete operating charge of both refrigerant and compressor oil.

.8 Controls, Safeties, and Diagnostics:

.1 Unit controls shall include the following minimum components:

.1 Microprocessor with non-volatile memory. Battery backup system shall not be accepted.

.2 Separate terminal block for power and controls.

.3 Control transformer to serve all controllers, relays, and control components.

.4 ON/OFF control switch.

.5 Replaceable solid-state controllers.

.6 Pressure sensors shall be installed to measure suction and discharge pressure. Thermistors shall be installed to measure cooler entering and leaving fluid temperatures as well as optional heat reclaim condenser entering and leaving fluid temperatures, and refrigerant pump down pressure and temperature.

.2 Unit controls shall include the following functions:

.1 Automatic circuit lead/lag.

.2 Hermetic scroll compressors are maintenance free and protected by an auto-adaptive control that minimizes compressor wear.

.3 Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1°F (0.06°C).

.4 Limiting the chilled fluid temperature pulldown rate at start-up to an adjustable range of 0.2°F to 2°F (0.11°C to 1.1°C) per minute to prevent excessive demand spikes at start-up.

.5 Seven-day time schedule.

.6 Leaving chilled fluid temperature reset from return fluid and outside air temperature.

.7 Chilled water pump and optional heat reclaim condenser water pump start/stop control and primary/standby sequencing to ensure equal pump run time.

.8 Dual chiller control for parallel chiller applications without addition of hardware modules and control panels (additional thermistors and wells are required).

.9 Timed maintenance scheduling to signal maintenance activities for pumps, strainer maintenance and user-defined maintenance activities.

.10 Low ambient protection to energize cooler and optional heat reclaim or hydronic system heaters.

.11 Periodic pump start to ensure pump seals are properly maintained during off-season periods.

.12 Single step demand limit control activated by remote contact closure.

.13 Generation of 0 to 10 vdc signal to control 3-way valve position when optional heat reclaim is employed.

.14 Nighttime sound mode to reduce the sound of the machine by a user-defined schedule.

.3 Diagnostics:

.1 The control panel shall include, as standard, a scrolling marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display with time and date stamp.

.2 Information included for display shall be:

.1 Compressor lockout.

.2 Loss of charge.

.3 Low fluid flow.

.4 Cooler coil and optional heat reclaim coil freeze protection.

.5 Cooler set point.

.6 Optional heat reclaim set point.

.7 Chilled water reset parameters.

.8 Thermistor and transducer malfunction.

.9 Entering and leaving-fluid temperature.

.10 Evaporator and condenser pressure.

.11 System refrigerant temperatures.

.12 Chiller run hours.

.13 Compressor run hours.

.14 Compressor number of starts.

.15 Time of day:

.1 Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.

.2 Diagnostics shall include the ability to review a list of the 30 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.

.3 An alarm history buffer shall allow the user to store no less than 30 alarm events with clear language descriptions, time and date stamp event entry.

.4 The chiller controller shall include multiple connection ports for communicating with the local equipment network, the Carrier Comfort Network® (CCN) system and access to chiller control functions from any point on the chiller.

.5 The control system shall allow software upgrade without the need for new hardware modules.

.16 Crankcase heater failure.

.4 Safeties:

.1 Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:

.1 Loss of refrigerant charge.

.2 Reverse rotation.

.3 Low chilled fluid temperature.

.4 Thermal overload.

.5 High pressure.

.6 Electrical overload.

.7 High heat reclaim leaving fluid temperature.

.2 Condenser fan and factory pump motors shall have external overcurrent protection.

.9 Operating Characteristics:

.1 Unit shall be capable of starting and running at outdoor ambient temperatures from 32˚F to 125˚F (0°C to 52˚C) for all sizes.

.2 Unit shall be capable of starting up with 95˚F (35˚C) entering fluid temperature to the cooler.

.10 Motors:

.1 Condenser-fan motors shall be totally enclosed single-speed, 3-phase type with permanently lubricated bearings and Class F insulation.

.11 Electrical Requirements:

.1 Unit/module primary electrical power supply shall enter the unit at a single location (some chiller voltage/size combinations require 2 power supplies).

.2 Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.

.3 Control points shall be accessed through terminal block.

.4 Unit shall be shipped with factory control and power wiring installed.

.5 Kilo Ampere Interrupting Capacity (kAIC) Rating:

.1 Equipment shall be rated a interrupting capacity rating of 25 kAIC.

.2 All products supplied to the site shall meet or exceed this kAIC rating.

.3 The kAIC rating may be lowered to match or exceed the available fault current indicated on the Short Circuit Co-ordination Study completed by the electrical trade.

.12 Chilled Water Circuit:

.1 Chilled water circuit shall be rated for 300 psig (2068 kPa). Units with optional pump package are rated for 150 psig (1034 kPa) working pressure.

.2 Thermal dispersion proof of flow switch shall be factory installed and wired.

.13 Special Features:

.1 Certain standard features are not applicable when the features designated by * are specified. For assistance in amending the specifications, contact your Carrier representative.

.1 High-efficiency variable condenser fans:

All fans on the unit shall have variable speed fan motors to provide higher part load efficiency and reduced acoustic levels. Each fan circuit shall have a factory-installed, independent variable speed drive with display. Variable speed drives are rated IP-55 enclosures and UL Listed. The use of this option, with the addition of antifreeze in the cooler circuit and wind baffles, shall allow running with outdoor ambient temperatures down to –20˚F (–28.9˚C). This option is not available with sizes 060 and 070, and it is not available in combination with low ambient head pressure control.

.2 Unit-Mounted Non-Fused Disconnect:

Unit shall be supplied with factory-installed, non-fused electrical disconnect for main power supply. This option is not available on 30RB060-120 with dual point power. This option is included with the high SCCR option.

.3 Aluminum fin/copper tube coils:

Coil shall be constructed of seamless copper tubes mechanically bonded to aluminum fins. Fins shall have wavy enhancements. These condenser coils are recommended with remote cooler applications. These coils are not recommended for corrosive environments.

.4 Remote Enhanced Display:

Unit shall be supplied with indoor-mounted, remote, 40-character per line, 16-line display panel for field installation.

.5 Minimum Load Control:

Unit shall be equipped with factory (or field) installed, microprocessor-controlled, minimum load control that shall permit unit operation down to a minimum of 6% capacity (varies with unit size). This option/accessory is not available on applications with leaving fluid temperature less than 38˚F (3.3˚C).

.6 Energy Management Control Module:

A factory or field-installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point reset or demand limit control; 2-step demand limit control (from 0% to 100%) activated by a remote contact closure; and discrete input for “Ice Done” indication for ice storage system interface.

.7 Condenser Coil Trim Panels and Security Grilles:

Unit shall be supplied with factory or field-installed coil covers and painted grilles to protect the condenser coil and internal chiller components from physical damage.

.8 Full End Screen:

Unit shall be equipped with a factory-installed option consisting of louvered panels that cover the machine ends from top to bottom and firmly fasten to the machine frame. These end screens function as a privacy screen and also provide hail protection.

.9 BACnet/Modbus Translator Control:

Unit shall be supplied with factory or field-installed interface between the chiller and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485). Field programming shall be required.

.10 Compressor Suction Service Valve:

Standard refrigerant discharge isolation and liquid valves shall enable service personnel to store the refrigerant charge in the cooler or condenser during servicing. This factory-installed option (one valve per refrigerant circuit) shall allow for further isolation of the compressor from the cooler vessel.

.11 Suction Line Insulation:

Insulation shall be tubular closed-cell insulation. This option shall be required on applications with leaving fluid temperatures below 30˚F (–1.1˚C) and recommended for areas of high dewpoints where condensation may be a concern.

.12 Freeze Protection Cooler Heaters:

Cooler heaters shall provide protection from cooler freeze-up to –20˚F (–29˚C).

.13 CRN Cooler (Canada Only):

Shall provide minor cooler modifications to meet Canadian code.

.14 Service Option:

The service option shall provide a remote service port for Navigator connection and a factory-installed convenience outlet which includes 4-amp GFI (ground fault interrupt) receptacle with independent fuse protection. Convenience outlet shall be a 115-v female receptacle. Service option shall not be available with 380-v.

.15 Compressor Sound Reduction:

Shall provide sound reduction for the scroll compressors.

.1 Unit shall be equipped with factory-installed option low sound - compressor sound reduction blanket which reduces unit sound levels by providing an acoustic blanket on each compressor.

.16 High SCCR (Short Circuit Current Rating):

The optional high SCCR (short circuit current rating) device shall allow the chiller to tolerate a 65 kA (208/230 and 460-v units) or 25 kA (575-v units) short circuit current for a brief period of time while protecting downstream components. The high SCCR option shall provide a higher level of protection than the standard unit. This option is not available on 30RB060-120 units with dual-point power. This option is also not available for 30RB170 and 30RB190 208/230-v single point models and 30RB275 and 30RB300 208/330-v dual point models. This option includes the unit-mounted non-fused disconnect option.

.17 GFI Convenience Outlet:

Shall be field installed and mounted with easily accessible 115-v female receptacle and shall include a 4-amp GFI receptacle.

Part 3 Execution

3.1 GENERAL

.1 Install unit as indicated, to manufacturers recommendations, and in accordance with EPS 1/RA/2.

.2 Ensure adequate clearances for servicing and maintenance.

.3 Manufacturer to approve installation, to supervise startup and to instruct operators. Include 4 hours of training.

.4 Provide isolation valves, strainers, thermometers, thermowells, pressure gauges, etc. entering and leaving chiller.

.5 Note: Plate heat exchangers in chillers could need 50 mesh strainers or smaller. Consult chiller manufacture to install the proper strainer mesh.

.6 On chillers with 100 mm (4") piping or greater use basket strainers with a OAR of 7.0 or greater.

3.2 PIPING SYSTEM FLUSHING PROCEDURES

.1 Piping system flushing procedure:

.1 Prior to connecting the chiller to the condenser and chilled water loop, the piping loops shall be flushed with a detergent and hot water 43-55°C (110-130°F) mixture to remove previously accumulated dirt and other organic. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

.2 During the flushing 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean. Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

.3 Prior to supplying water to the chiller, the Water Treatment Specification shall be consulted for requirements regarding the water quality during chiller operation. The appropriate chiller manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

3.3 WATER TREATMENT REQUIREMENTS

.1 Supply water for both the chilled water circuit shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the chiller's heat exchangers, headers, and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the following parameters:

.1	pH	Greater than 7 and less than 9
.2	Total Dissolved Solids (TDS)	Less than 1000 ppm
.3	Hardness as $CaCO_3$	30 to 500 ppm
.4	Alkalinity as Ca CO_3	30 to 500 ppm
.5	Chlorides	Less than 200 ppm
.6	Sulfates	Less than 200 ppm

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 on all parts.

.2 Five (5) year on compressors.

.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.

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.

2.2 HEAT WHEEL AIR TO AIR ENERGY RECOVERY VENTILATOR

.1 General

.1 Packaged, energy recovery ventilator(s) (outdoor or indoor as shown in equipment schedule) consisting of enthalpy wheel, wheel drive system, ventilation air fan, exhaust air fan, necessary dampers, temperature sensors, and microprocessor controls.

.2 Unit Cabinet

.1 Cabinet shall be constructed of 20 gauge G-90 galvanized steel with 12 gauge galvanized frame.

.2 Outdoor units to have series 8,000 exterior pre-paint surface consisting of baked-on polyester paint on G-90 base metal. Metal finish shall withstand a minimum of 10 years of exterior exposure without cracking, chipping, peeling, brazing, or spotting.
Outdoor units shall have no screw penetrations on the roof and shall be airtight and waterproof.

.3 Outdoor units shall have lifting holes at unit base for rigging onto rooftop.

.3 Access

.1 Access to all components that require servicing shall be provided through sealed and easily removable access panel(s).

.2 Enthalpy wheel shall be easily removable from the unit.

.4 Enthalpy Wheel

.1 The enthalpy wheel shall be constructed of fluted synthetic fibrous media, impregnated with a non-migrating water selective 4 angstrom molecular sieve desiccant. Wheel media shall be 4 inch (6 inch) thick. Energy transfer ratings shall be ARI certified in accordance with the ARI *Air-to Air Energy Recovery Ventilation Equipment Certification Program,* based on ARI Standard 1060-2000.

.2 Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and ARI Standard 1060.

.3 Manufacturer shall provide verification (in writing) confirming that the internal pore diameter distribution inherent in the desiccant limits adsorption to materials no larger than the critical diameter of a water molecule (4.0 Angstrom).

.4 Energy recovery wheel shall be constructed of aluminum and must comply with NFPA-90A for flame spread and smoke generation.

.5 Enthalpy wheel drive belt shall be designed so that there is no need for a take-up pulley and no field adjustments required (0% stretch after initial tension).

.6 Enthalpy wheel cassette shall be complete with face seal and perimeter seal to prevent cross leakage between the two airstreams. Both seals shall be contact seals (non-wearable) to prevent leakage from occurring at the seal.

.7 Enthalpy wheel shall come complete with an adjustable purge section to eliminate carry over of exhaust air stream contaminates from wheel rotation.

.8 Enthalpy wheel shall be self cleaned by two counter flow airstreams.

.9 Enthalpy wheel shall be installed in removable cassette to allow for inspection, removal and cleaning.

.5 Operating Characteristics

.1 Unit shall be capable of providing a constant volume of air at a specified external static pressure at all fan operating speeds.

.6 Blowers

.1 Fan ratings are based on tests made in accordance with AMCA Standard 210.

.2 Blowers must be selected to operate on a stable efficient part of the fan curve when delivering air quantities scheduled against static of the system.

.3 Fan blades shall be statically and dynamically balanced and tested prior to shipment.

.4 Fan shall be provided with internal vibration isolation mounts.

.5 Fan discharge shall be as noted on the plans.

.7 Motors

.1 Motors shall be continuous duty, permanently lubricated, and matched to the fan loads.

.2 Motors shall meet new EPAC regulations for efficiency and shall have inverter spike resistance wire for protection.

.8 Electrical Requirements

.1 Unit shall have single point power connection only.

.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 Filtration

.1 Unit must come equipped with standard size medium efficiency filtration (30% DSE.)

.10 Integration with A2L Containing Ductwork Systems

.1 ERV is integrated/connected to an air handling system containing an A2L refrigerant. All electrical components, (actuators, motors etc.) within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code).

.11 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 terminal strip complete with circuitry to allow the follow operational characteristics:

.1 dry contacts for occupancy control (start/stop)

.2 remote fan interlock on call for ventilation

.3 selection of low or high speeds

.4 remote wall control contacts

.5 free cooling enthalpy contacts to stop wheel rotation

.6 general alarm contact

.7 forced exhaust mode

.8 24 VAC contacts (30VA) for external components

.4 Provide BACNet Card

.12 Accessories

.1 Frost Protection (writer to select one minimum)

.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 Hoods (for roof mounted units only)

.1 Unit shall include intake and exhaust hoods with birdscreen.

.2 Maximum design velocity on intake hood must not exceed 200 ft/min.

.3 Hoods to include dampers with spring return, two way driven actuators, and/or and exhaust backdraft damper.

.3 Double Wall Construction

.1 Cabinet shall be insulated throughout and lined with a 26 ga. galvanized wall to eliminate potential puncture of insulation membrane.

.4 Disconnect Switch

.1 Unit shall include fused or non-fused disconnect switch.

.5 Access Panels

.1 Unit shall have deluxe door access for filters and blower doors consisting of ¼ turn fasteners and polymide handles.

.6 Wheel Rotation Sensor

.1 Sensor device and contacts shall be included to provide a low voltage signal when wheel rotation stops longer than the sensor set point.

.7 Enthalpy Wheel Purge Section

.1 Enthalpy wheel cassette shall include a purge section which is field adjustable from 7.5 to 12.5 rpm.

.8 Roof curb

.1 Roof curb shall be constructed of galvanized steel.

.2 Roof curb shall be knock down type complete with instructions for field assembly matched to unit specifications.

.9 Free Cooling Enthalpy Control

.1 Free cooling enthalpy control shall be provided to stop wheel when applicable on calls for cooling.

.13 Acceptable Manufacturers:

.1 Aldes

.2 Greenheck

.3 Ruskin

.4 Cook

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 wheel.

.2 One (1) year warranty on all 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/NFPA-90A, Installation of Air Conditioning and Ventilating Systems.

.3 AMCA 99 – Standard Handbook.

.4 AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.

.5 ARI 270, Standard for Sound Rating of Outdoor Unitary Equipment.

.6 ANSI/AHRI 340/360 – Performance Rating of Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment.

.7 AMCA 500 – Test Methods for Louvers, Dampers, and Shutters.

.8 AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment.

.9 NFPA 90A – Installation of Air Conditioning and Ventilation Systems.

.10 UL-1995 – Standard for Safety for Heating and Cooling Equipment.

.11 C.1 CSA B52-2023, Mechanical Refrigeration Code

.12 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 Section general requirements.

1.3 MAINTENANCE DATA

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

1.4 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with general requirements.

1.5 UNIT ASSEMBLY

.1 Unless stated otherwise, air handling units are to be shipped to the job in one piece, factory assembled. All equipment shall be factory tested prior to shipment.

1.6 MANUFACTURED ITEMS

.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 in force.

.2 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.3 Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.

1.7 PERFORMANCE RATINGS

.1 Unit certification: Units shall conform to CSA-C746-2006 and ARI 340/360-2007 and shall be listed by NRCan as approved for sale in Canada and be compliant with the SB-10 Supplement of the Ontario Building Code. Testing shall be completed by a third party, certified lab.

Part 2 Products

2.1 GENERAL

.1 Field Factory assembled components to form units supplying air at design conditions as indicated and specified.

.2 Acceptable Manufacturers:

.1 Daikin

.2 Engineered Air

.3 Haakon

.4 Bousquet

2.2 UNIT CONSTRUCTION

.1 Unit casing shall be of minimum 1.6 mm (18 gauge) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All high pressure 1250 Pa (5" w.c.) to 2250 Pa (9" w.c.) fan sections shall be constructed of 2 mm (14 gauge) metal. Continuous high pressure sealant shall be provided between all panels.

.3 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.4 The following components shall be provided with a 0.85 mm (22 gauge) solid, or 0.70 mm (24 gauge) 40% free area perforated galvanized metal liner over insulated areas:

	Solid Liner	Perf. Liner
Fan Sections	____	X
Coil Sections	X	___
Filter Sections	X	___
Mixing Sections	X	___
Access Sections	X	___
Humidifier Sections	X	___
Underside of Unit (where visible)	X	___

.5 Units shall be provided with gasketed access doors to the following components: fans and motors; filters; dampers and operators; access plenums and humidifiers/wet cells. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.6 Provide hinged access doors, fully lined, with zinc plated piano hinges and brass pins, Leverlock handles, operable from both sides for all units.

Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.
Hinged access doors shall be provided with tie back clips.

.7 Casings shall be supported on formed 200 mm (8") high (minimum) galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

.8 All units shall be internally insulated with 50 mm (2") thick 24 kg/cu.m. (1 1/2 lb./cu.ft.) density, neoprene coated fibre glass thermal insulation (24 kg/cu.m) (1 1/2 lb/cu.ft). insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 400 mm (16") o/c.. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.9 Unit casing floors in walk in sections shall be fabricated with 2.0 mm (14 gauge) galvanized checker plate steel. Provide reinforcing channels under floor to minimize deflection.

.10 Cooling unit drain pans shall be an integral part of the floor panelling, a minimum of 50 mm (2") deep, with welded corners. Drain pans shall extend a minimum of 300 mm (6") downstream of coil face and be provided with a 25 mm (1") M.P.T. drain connection. Drain pans must be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided between cooling coils above 1650 mm (65"). Extend drain under complete fan section where fan is downstream of humidifier. Drain pans shall be stainless steel.

.11 In air-to-air heat reclaim units, the exhaust section drain pans shall be an integral part of the floor panelling, a minimum of 50 mm (2") deep, with welded corners. Drain pans shall extend over the full exhaust fan plenum and be connected with a 40 mm (1 1/2") M.P.T. drain connection

2.3 STARTERS AND CONTACTORS

.1 Provide unit mounted starters for all fans. Locate starters in unit control panel. All fans and starters shall be internally wired for single point connection.

.2 Starters shall conform to CSAC22.2 No. 14 (latest edition) and EEMAC E14-1.

.3 Control transformers shall conform to CSAC22.2 No. 66 (latest edition). Control transformer shall be suitable for controlling function. Coordinate with Building Automation Contractor.

.4 Wire fan motors to external unit mounted junction box complete with terminal strip.

.5 Run all wiring in conduit to standards of Division.

2.4 KAIC RATING

.1 Kilo Ampere Interrupting Capacity (kAIC) Rating

.1 Equipment shall be rated a interrupting capacity rating of 25 kAIC.

.2 All products supplied to the site shall meet or exceed this kAIC rating.

.3 The kAIC rating may be lowered to match or exceed the available fault current indicated on the Short Circuit Co-ordination Study completed by the electrical trade.

2.5 FANS

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans of 450 mm (18") or less diameter, shall be equipped with permanently lubricated cartridge ball bearings, supported by a 3 point "spider" bearing bracket in the fan inlets. All other forward curved fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.3 Airfoil and BI fans shall be equipped with greaseable, self aligning ball or roller type pillow block bearings.

.4 Airfoil and BI fans shall be plenum type configuration where noted in schedules. Plenum fan assemblies shall be encapsulated by an open wire mesh protective screen. Removable screens at access doors are not acceptable. Thrust restraint isolators shall be provided at shaft centreline when required to minimize axial movement and bending movements of the blower assembly(s). Drive side bearings on Plenum fans shall be adapter style to ensure even clamping of the bearing sleeve to the shaft.

.5 Drives shall be adjustable on fans with motors 3.73 kW (5 hp) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

.6 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.7 Provide OSHA approved belt guards on all units with walk in sections over 1500 mm (60") high.

.8 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 225mm (9") to 375mm (15") forward curve fans. All other fans shall incorporate vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 25 mm (1") static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.9 Single phase belt drive motor applications shall include rubber isolation for motors .19kW (1/4 hp) through 1.1kW (1 1/2 hp). Provide internal spring isolation for motors over 1.1 kW (1 1/2hp)

.10 Provide extended grease lines terminating outside the serviceable side of the unit.

.11 Fan motors shall be ODP high efficiency induction motor.

2.6 COILS

.1 Coils shall be Ultrafin and/or Superfin as manufactured by Engineered Air, constructed of copper tube, aluminum fin, copper headers with schedule 40 steel pipe connectors, male N.P.T. Fins constructed of aluminum shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 2070 kPa (300 psig) while immersed in an illuminated water tank.

.2 Headers shall be outside the air handling unit for maximum serviceability. The non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with 15 mm (1/2") MPT drain connection at headered end of cooling coils.

.3 Provide an insulated header cover to conceal exposed headers.

.4 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings. All water coils shall be equipped with a capped vent tapping at the top of the return header, and a capped drain tapping at the bottom of the supply header.

.5 Coils shall be cleanable type provided with brass fittings and removable plugs for each tube at the return end.. Cast iron headers must have brass plugs to prevent oxidization.

.6 Water and glycol coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.

.7 Ultrafin water coils shall be A.R.I. Certified.

2.7 RECOVERY AIR TOTAL ENERGY WHEEL

.1 Provide an ARI certified (sizes AEW10-1200 to AEW10-3500) Recovery Air wheel as manufactured and supplied by Engineered Air. The performance of the wheel is to be ARI tested and certified as an individual component. The effectiveness shall be reflective of the component performance only without the benefit of packaged equipment.

.2 The wheel shall be constructed of sheet aluminum, with alternate layers glued to each other for stability. Wheels shall be tension wound on to a central hub. All aluminum surfaces shall be coated with a "zeolite" 4 Å molecular sieve coating to provide water vapor transfer from one air stream to the other. Latent heat transfer rate shall be equal to sensible heat transfer rate, ±6%, throughout the complete range of operation. The wheel shall be cleanable with compressed air without damage to the aluminum or desiccant. Alternate reclaim devices shall meet or exceed the performance noted in the schedules without exceeding the fan power requirements specified.

.3 Wheels are held securely together with metal spokes extending radially from the hub to the peripheral banding. Spokes are flush mounted to rotor media. Wheels of 1800 mm diameter and smaller are provided in one piece construction. Larger wheels are constructed in 4 or 8 removable pieces. Alternatively, the smaller wheels can also be provided in 4 piece construction.

.4 The wheel shall be supported by two pillow block bearings which in turn are supported by a steel support. The bearings shall be located in the shadow of the bearing support member and the division between air streams to maximize the free area of the rotor as much as possible. The bearings shall be replaceable without removing the wheel from the air handling unit.

.5 Wheels shall be provided with non-contact labyrinth seals around the perimeter of the wheel and across the face at the division between the supply and exhaust sectors. Adjustable seals shall be spaced not more than 1/32" (.8 mm) from the rotor surface. The unit shall be provided with a purge system to allow a percentage of outdoor air to sweep through the exhaust air sector to eliminate the possibility of exhaust air to the supply air stream.

The manufacturer shall ensure that the pressure at the entering side of the exhaust air sector of the wheel is lower than the pressure at the entering side of the supply air sector. In the case of draw-through fans, this will necessitate a field adjustable damper in the exhaust system upstream of the total energy wheel. The manufacturer shall select the supply and exhaust fans to provide the additional air for purge where required.

.6 The wheel shall be driven by a continuous V-belt around the outer perimeter of the wheel connected to a 3 phase, inverter driven, high torque/high turndown, AC motor (gear motor for model sizes 600 – 1500) for variable speed applications, or a 3 phase AC motor for constant speed applications. Access to the motor and the drive shall be from the face of the wheel.

.7 Variable speed control:(for applications where the discharge air temperature and/or frost prevention is required)

.1 Provide a solid state control system, equal to the Engineered Air W-TRAC, to provide discharge air temperature control, free-cooling function, summer-winter changeover, and prevention of frost formation on the wheel when necessary.

.2 An adjustable set point on the face of the W-TRAC shall allow a selection of 52°F to 74°F (11°C to 23°C) discharge air temperature. In the heating mode, as the discharge air temperature nears the set point, the speed of rotation of the wheel is slowed to maintain set point. When the minimum speed is reached, and there is a cooling demand, the wheel will stop completely. The wheel will remain off until the outdoor air temperature exceeds the exhaust air temperature, at which time the wheel will resume operation at full RPM.

.3 The frost prevention mode overrides the temperature control mode and may be enabled in several ways:

.4 When the outdoor air temperature drops below the frost threshold, the wheel speed is controlled to maintain a specific dry bulb temperature in the exhaust air that coincides with 90% RH. The calculated value is based on the estimated space RH, which is a selectable feature on the W-TRAC.

.5 An RH sensor installed in the exhaust air leaving the wheel will directly vary the wheel RPM to limit the exhaust air humidity to 90%.

2.8 FILTERS

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.

.2 For units with filter banks 1829 mm (72") high or less, the filter modules shall be designed to slide out of the unit. Side removal filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.

Bag or cartridge type filters shall slide into an extruded aluminum track against a gasketted sealer strip. Associated 50 mm (2") prefilters shall slide into an integral track in the aluminum extrusion.

.3 50 mm (2") MERV 13 Pleated Panel Disposable Filters: Non-woven re-inforced cotton/poly fabric media with a metal support grid and heavy duty beverage board enclosing frame. The filter media shall have an average efficiency of 30-35%+ on ASHRAE Standard 52.1.

.4 Rigid Self-Supporting Extended Surface Disposable Filters: Filters shall consist of high density synthetic media, media support grid, metal contour stabilizers, metal diagonal support bracing and enclosing frame. Media shall be 3 ply, dual stage synthetic. Pre-filter layer of coarse 7-10 micron synthetic fibers; secondary ply of progressively structured spun bonded polypropylene fibers blended with filaments from 1 to 6.7 microns; and final ply of spun bonded polypropylene backing with strength to support filtering stages. The media shall withstand 100% humidity and be non-shedding. Media shall have an average atmospheric efficiency of 85-90% with an average arrestance of 96 to 100% when tested to ASHRAE 52.1 - 1992. Media shall be quality certified by ISO-9002.

.5 Media support shall be expanded, electro-galvanized grid with an effective open area of not less than 97%. The expanded metal grid shall be bonded to the filter media, eliminating the possibility of media oscillation and pullaway. Contour stabilizers of galvanized steel shall be installed on both air entering and exiting sides of the media pack. The filter shall be capable of withstanding 2.49 kPa (10" w.c.) pressure drop without noticeable distortion of the media pack. The enclosing frame shall be 0.55 mm (26 gauge) steel with the media pack mechanically and chemically bonded to the inside periphery.

.6 Filter media shall meet U.L. Class 2 standards.

.7 Provide filter bank with "Dwyer 2000 magnehelic" air filter gauge, complete with static pressure tips and aluminum tubing, all factory installed. Filter gauge to have a range of 0- 500 Pa (0-2" w.c.). Where two or more filter banks are connected to a single gauge, multiple gauge kit with manual shut-off cocks in the air tubing shall be provided.

.8 Where the filter gauges are provided on outdoor units they shall be mounted inside of a weatherproof enclosure with viewing window.

2.9 DAMPERS

.1 Damper frames shall be u-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 15 mm (1/2") aluminum, shall turn in bronze bushings, fabricated from self- oiling bronze. Rods shall be secured to the blade by means of straps and set screws.

.2 Blades shall be 1.3 mm (18 gauge) galvanized metal with two breaks on each edge and three breaks on centreline for rigidity. The pivot rod shall "nest" in the centreline break. Damper edges shall interlock. Maximum length of damper between supports shall be 1070 mm (42"). Damper linkage brackets shall be constructed of galvanized metal.

.3 Dampers shall be:

Low leak dampers shall include blade ends sealed with an adhesive backed foamed polyurethane gasketting. Interlocking blade edges shall include an all weather PVC seal, fastened with a positive lock grip and pliable overlap edges on both the entering and leaving air sides. Pivot rods extend the full length of damper blades and are interlocked on the side through crank arms.
Certified low leak, dampers shall also be provided for return air dampers, exhaust (relief) air dampers.

.4 Mixing dampers shall be parallel blade type.

.5 Two position inlet dampers shall be parallel blade type.

.6 Motorized relief dampers shall be opposed blade type.

.7 Provide Engineered Air satin coat steel mixers downstream of mixing box to provide thorough air mixing to prevent stratification.

.8 Damper operators will be supplied by the temperature controls contractor and factory installed by the unit manufacturer.

2.10 COMPONENTS

.1 Incorporate the following components to provide a complete system.

.1 Return air blower with vertical inlet
.2 Outdoor air/relief section
.3 Mixing section
.4 Filter section
.5 Energy Recovery Wheel
.6 Glycol Heating Coil Section
.7 Glycol Cooling coil section
.8 Supply air blower

2.11 ACCESSORIES

.1 Dead front disconnect.

.2 Internal wiring to terminal strip in Nema 1 enclosure with “soft start”. Provide space for DDC controller. All units shall be internally wired for a single point connection.

.3 Belt guards.

.4 Second (2nd) coat of finish paint (standard colour).

2.12 CAPACITY

.1 Provide unit capacity indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Fabricate to provide smooth air flow through all components. Limit air leakage to 1% of rated air flow at 2.5 kPa (10" w.c.) suction pressure.

.2 Apply sealer into all seams prior to assembly. Secure toe angles continuous along entire length of assembly.

.3 Install to manufacturers requirements.

3.2 FANS

.1 Provide sheaves and belts required for final air balance.

.2 Suspension for hung units: install four part hanger type, ceiling flange, top hanger, bottom hanger and vibration isolator with takeup for leveling.

.3 Install flexible connections at fan outlets. Ensure metal bands of connectors are parallel and not touching when fan is running and when fan is stopped. Ensure that fan outlet and duct are aligned when fan is running.

3.3 DRAIN PAN

.1 Install deep seal P trap on drain lines. Depth of water seal to be 2.5 times static pressure at this point.

3.4 START-UP/COMMISSIONING

.1 Unit manufacturer shall perform start-up and commissioning.

3.5 SPARE PARTS

.1 Two (2) complete sets of filters.

.2 One (1) set of spare belts.

3.6 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.

3.1 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 One (1) year on parts and labour on all components.
- .3 Ten (10) years on heat exchanger

.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 ACCEPTABLE MANUFACTURERS

.1 Trane

.2 JCI

2.2 HIGH EFFICIENCY HVAC EQUIPMENT (15 TONS & LESS)

.1 Efficiency:

.1 Units under 5 tons of cooling meet a SEER rating of 14.0.

.2 Units 6 tons of cooling and larger meeting a EER rating of 12.0 (9.6 for 12½ ton unit).

.3 Electronic controls with data link and diagnostic operation.

.4 Energy Star rated.

.2 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 Dehumidification package, factory installed and tested for identified units.

.6 High efficiency motor suitable for voltage indicated. Provide two-speed motors on units 7½ tons and larger where noted in Schedule.

.7 All units shall be of the same manufacturer.

.8 Provide minimum 5-stage cooling (4 DX, 1 free cooling) control with multizone VAV operation (Variable Speed Fan)

.3 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: hinged access doors with lockable quarter turn handles.

.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.

.4 Fans:

.1 Centrifugal, backward inclined impellers, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, isolated hinge mounted motor. Vibration isolators: 95% efficiency.

.2 Fan to be suitable for variable speed control thru VFD for VAV operation.

.5 Air Filters:

.1 50 mm (2") thick, MERV 13 Filters standard to unit manufacturer.

.2 To meet ANSI/NFPA 90A, air filter requirements.

.6 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.

.7 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 automatic hot gas bypass, sight glass, filter and valves.

.5 Condenser: staggered copper tube aluminum fin coil assembly with sub-cooling rows.

.6 Capacity reduction: hot gas bypass and or cylinder unloading.

.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.

.8 Dehumidification Package:

.1 Factory installed and tested sub-cooling coil on leaving air side of evaporator coil to sub-cool the hot liquid refrigerant leaving the condenser coil. Package also consists of crankcase heaters, low pressure switch (es) and TX valves, piped, and wired at factory. Operation of sub-cooling coil is as indicated.

.9 Controls and Safeties:

.1 Electronic controller.

.2 Network monitoring.

.3 Scrolling Marquee display.

.4 Unit control with standard suction pressure transducers and condensing temperature thermistors.

.5 Provide a 5 F° temperature difference between cooling and heating set points to meet ASHRAE 90.1 Energy Standard.

.6 Display a current alarm list and an alarm history list.

.7 Automatic compressor redundancy.

.8 Service run test capability.

.9 Shall accept input from a CO_2 sensor (both indoor and outdoor).

.10 Configurable alarm lights shall be provided which activates when certain types of alarms occur.

.11 Compressor minimum run time (3 minutes) and minimum off time (5 minutes).

.12 Service diagnostic mode.

.13 Economizer with enthalpy control.

.14 Self-contained low-voltage control circuit.

.15 Solid-state compressor lockout which provides optional reset capability at the space thermostat, should any of the following safety devices trip and shut off compressor:

.1 Compressor lockout protection provided for either internal or external overload.

.2 Low-pressure protection.

.3 Freeze protection (evaporator coil).

.4 High-pressure protection (high pressure switch or internal).

.5 Compressor reverse rotation protection.

.6 Loss of charge protection.

.16 Supply-air sensor located in the unit and detect both heating and cooling operation.

.17 Induced draft heating section with the following minimum protections:

.1 High-temperature limit switch.

.2 Induced-draft motor speed sensor.

.3 Flame rollout switch.

.4 Flame proving controls.

.5 Redundant gas valve.

.18 All control components shall utilize industry standard input/outputs. (i.e 0-10vDC). Proprietary voltages, communication languages etc. between components is not acceptable.

.10 Unit Controls:

.1 In addition to combustion safety controls, provide low limit on supply.

.2 Zone cooling control:

.1 Zone sensor or 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 Adjustable zone sensor or 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.

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 all units (with field installed wiring).

.7 Stainless steel vertical extension on flue gas discharge.

.8 Stainless steel heat exchanger.

.9 Provide hand knobs/levers for all access doors (Access shall not be with screwdriver).

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.

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 SYSTEM DESCRIPTION

.1 Indoor, wall-mounted, direct-expansion fan coil to be matched with the 38BN condensing or heat pump units.

.2 Outdoor-mounted, air cooled split system outdoor section suitable for on-the-ground, rooftop, wall hung, balcony, or under-deck installation. Unit shall consist of a scroll or reciprocating compressor, an air-cooled coil, propeller-type draw-thru outdoor fans, full refrigerant charge, and control box. Unit shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to-air system.

.3 System shall be used in a refrigeration circuit matched to both parts.

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 Quality Assurance: Unit shall be rated per ARI Standards 210/240 and listed in the ARI directory as a matched system. Units shall be UL listed for sale in the U.S.A. and Canada.

2.2 INDOOR FAN COIL

.1 Indoor, direct-expansion, wall-mounted fan coil. Unit shall be 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, and thermistor interconnection cable.

.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 Indoor fan shall be 3-speed 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 standard.

Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and air sweep may be manually set.

.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 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 54 F to 90 F. The unit shall have the following functions as a minimum:

.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.

.3 Temperature-sensing controls shall sense return-air temperature. Indoor air high discharge temperature shutdown shall be provided.

.4 Indoor coil freeze protection.

.5 Wireless infrared remote control to enter set points and operating conditions.

.6 Automatic airsweep control to provide on or off activation of airsweep louvres.

.7 Dehumidification mode shall provide increased latent removal capability by modulating system operation and setpoint temperature.

.8 Fan only operation shall provide room air circulation when no cooling is required.

.9 Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.

.10 An indoor to outdoor thermistor connection cable shall be provided with the fan coil unit.

.11 Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during all operating modes.

.12 A time delay shall prevent compressor restart in less than 3 minutes.

.13 Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.

.6 Filters: Unit shall have filter track with factory-supplied cleanable filters.

.7 Electrical Requirements: Unit shall operate on 208/230 V, 1 phase, 60 Hz power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.

2.3 OUTDOOR CONDENSING UNIT

.1 Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of R407a refrigerant, and special features required prior to field start-up.

.2 Unit cabinet shall be constructed of galvanized-steel, bonderized and coated with a baked-enamel finish.

.3 Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.

.4 Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

.5 Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall draw air through the outdoor coil.

.6 Outdoor fan motors shall be totally enclosed, single-phase motors with class B insulation and permanently lubricated sleeve bearings. Motor shall be protected by internal thermal overload protection.

.7 Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.

.8 Outdoor fan openings shall be equipped with coated protection grille over fan and coil.

.9 Compressor shall be fully hermetic reciprocating or scroll type.

.10 Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from overtemperature and overcurrent. Scroll compressors shall also have high discharge gas temperature protection if required.

.11 Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.

.12 Compressor assembly shall be installed on rubber vibration isolators.

.13 Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed.

.14 Refrigerant circuit components shall include brass external mixed phase line service valve, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, accumulator, pressure relief, and a full charge of refrigerant.

.15 Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

.1 Controls:

.1 Automatic restart on power failure.

.2 A time delay control sequence provided through the fan coil board.

.3 Automatic outdoor fan motor protection.

.4 Start capacitor and relay (single-phase units without scroll compressors).

.2 Safeties:

.1 System diagnostics provided through indoor controls.

.2 Compressor motor current and temperature overload protection.

.3 Outdoor fan failure protection.

2.4 REFRIGERANT

.1 Refrigerant shall be A1 or A2L Classified.

.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 The system shall be equipped with compressors and independent refrigeration circuits to limit the volume of refrigerant that may be released in the event of a leak.

.5 Provide additional compressors/circuits if required to keep charge below this value.

.6 Provide leak detection and solenoid valves to limit release volume from each circuit.

.7 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.

.8 Provide refrigerant leak detectors for installation in served space. Detector shall close refrigeration leak safety valve to limit charge released into space/atmosphere.

.9 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 initiative 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.

2.5 CONDENSATE PUMP

.1 The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Provide 1800 mm (6' - 0") power cord.

.2 Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 20 ft. A level sensor on the condensate pan shall stop cooling operation of the level in the condensate pan is unacceptable.

2.6 LOW-AMBIENT CONTROL KIT

.1 Low-ambient control kit shall regulate fan-motor cycles in response to saturated condensing pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100 F +/- 10 F with outdoor temperatures to –20 F. Installation of kit shall not require changing the outdoor-fan motor.

2.7 ELECTRICAL REQUIREMENTS

.1 All units shall operate on single-phase, 60 cycle power at 208/230V.

.2 Unit electrical power shall be a single point connection.

.3 Unit control voltage to the indoor-fan coil shall be 24V.

.4 All power and control wiring must be installed per NEC and all local building codes.

.5 High-voltage and low-voltage terminal block connections.

2.8 CAPACITY

.1 Refer to schedules.

2.9 ACCEPTABLE MANUFACTURERS

.1 LG

.2 Daikin

.3 Mitsubishi

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.

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 Contractor hereby warrants unit for one (1) year and refrigeration compressors for five (5) years.

.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/CGSB-51.40, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.

.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 coil: hydronic

.3 Heating coil: hydronic

2.2 FAN COILS

.1 Galvanized chassis, coil, fan housing(s) and wheel(s), fan deck, motor, insulated coil section, electrical junction box, ECM motor, galvanized drain pan, and plastic auxiliary drain pan.

.2 Exposed wiring shall be in flexible conduit on all ceiling hideaway units. Unit mounted electrical components shall be pre-wired to a junction box.

.3 Units shall have an externally insulated (304 SS optional) mounted directly below the coil for continuous condensate removal. Drain surfaces shall be separate from the fan deck assembly and shall carry condensate to a plastic auxiliary drain pan.

.4 Motors and fans shall be mounted on a removable galvanized steel fan deck assembly.

.5 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.

.6 All cabinets shall be of the type as shown on the drawings. Cabinets shall be manufactured from 16 gauge, epoxy powder coated, cold rolled steel panels with 14 gauge front panel. The entire cooling coil section shall be insulated with ¼" Armaflex insulation. Cabinet parts shall be cleaned and phosphatized before painting.

.7 Optional colors can be selected from the standard color chart.

.8 Cabinets shall have 8" end pockets on both sides of the internal cabinet for installation of electrical equipment or control valves. Floor and wall non-recessed top panels shall be supplied with two flush, hinged access doors with optional tamper-resistant fasteners.

.9 Adjustable rear mounting brackets shall be supplied with all cabinets to provide necessary adjustments to correct unit alignment during installation on untrue or non-square walls, studs, joints, and surfaces.

.10 A wall seal assembly shall be provided with all recessed units. The assembly shall provide a finished appearance to the ceiling or wall.

.11 The inlet plenum shall enclose the motor(s) and fan(s) and include a 1" filter rack.

.12 All fan wheels shall be forward curve, tablock, centrifugal, and double-width galvanized steel. All fan housing shall be constructed of painted cold rolled steel including mounting flange.

.13 Motors shall be ECM, totally enclosed, with integral thermal overload protection for 115V/60Hz/1Ph. All motors feature a standard shaft size of ½" diameter. Prior to shipping, all motors shall be assembled, factory tested and installed in the unit.

.14 Coils shall be constructed of 3/8” OD seamless copper tube mechanically bonded to aluminum fins. The entire coil assembly is factory tested to 450 psig air pressure when the coil is submerged in water. It shall have a maximum working pressure of 325 psig. Coil connections are ½”. Each coil shall be supplied with a manual air vent.

.15 Filters supplied shall be 2” MERV 13 replaceable filters.

.16 Provide vibration isolation hangers.

.17 Primary internal wiring and testing shall be conducted at the factory. All units shall be shipped with wiring diagrams.

.18 Capacity: as indicated.

.19 Acceptable Manufacturers:

.1 IEC

.2 Krueger

.3 Trane

2.3 ACCESSORIES

.1 Factory mounted disconnect/service switch

.2 Filter box / mounting rack

.3 Vibration isolation hangers

Part 3 Execution

3.1 GENERAL

.1 The installing contractor shall provide and install between the indoor and outdoor unit the interconnecting refrigerant tubing of the size recommended by the unit manufacturer. The installing contractor shall evacuate the indoor coil and interconnection tubing and charge the system in accordance with manufacturer's recommendations.

.2 Install as indicated, to manufacturers' recommendations.

.3 Manufacturer to certify installation.

.4 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.

3.2 EQUIPMENT 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.

.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 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 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Indicate:

- .1 Equipment, capacity, piping, and connections.
- .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
- .3 Special enclosures.

.3 Primer coat to be off white.

.4 All hydronic heating shall be by a single manufacturer.

1.2 MAINTENANCE DATA

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

Part 2 Products

2.1 DAMPERS

.1 Factory built, internal damper, complete with operator, at enclosure air outlet grille for each convection type heating unit not thermostatically controlled. Refer to schedules on drawings.

2.2 CAPACITY

.1 As indicated.

2.3 FREE STANDING FINNED TUBE RADIATION (H-1)

.1 Copper-aluminum element shall be NPS 32 (1¼") nominal I.D. seamless copper with 4" x 4" (102 mm x 102 mm) aluminum fin. Fins to be stamped for rigidity and have integral collars to provide even spacing of 50 fins/foot (164 fins/m) and maximum heat transfer. Tube ends suitable for seat connecting. Heavy gauge element hangers shall be provided for mounting on the enclosure bracket and shall consist of galvanized rigid steel hanger with peg board style mounting hook and nylon roller bearing to allow for free expansion. Element hanger shall swing from mounting hole for free expansion of element. Centre on minimum 4 ft. (1.2 m).

.2 Element: cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm (36") centers maximum.

.3 Pedestal legs will mount solidly on the floor. The legs will have an adjustable bracket to accommodate floor level variation. Element hangers will mount on the vertical member of the enclosure bracket at desired height. The front panel will mount into the back panel integral joggle strip. The bottom of the panel is retained by the spring clip. Enclosure is 300 mm (12") high 18 gauge cold rolled steel with a factory baked-on white primer finish, with stamped top grille and open bottom.

.4 Corners: Corners are one piece and cover the back panel as well as the front panel. Gently spread the corner apart and place over the enclosure. Bend tabs at bottom in front and back securing it to the enclosure.

.5 Standard enclosures: 300mm (12") high, 1.6 mm (16 gauge) thick steel complete with stamped grille, components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces to be flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Joints and filler pieces to be clear of grilles located to provide easy access to valves and vents. Provide access doors for valves. Finish cabinet with factory applied baked paint coat. Enclosure height as indicated. Sloping top open bottom.

.6 Laps: Used where the enclosure is wall to wall. Laps are one piece and cover back panel as well as the front panel. Gently spread the lap apart and place over the enclosure. Bend tabs at bottom in front and in back securing it to the enclosure.

.7 End caps: Complete the enclosure installation by installing end caps where required.

.8 Dimensions for enclosures: Measure site conditions. Do not scale from drawing. Provide wall to wall installation.

.9 Provide for noiseless expansion of all components.

.10 Expansion compensators: Flexonics at each section by mechanical contractor as specified elsewhere.

.11 Acceptable Manufacturers:

.1 Engineered Air WF 2A-FS

.2 Dunham Bush

.3 Sigma

2.4 FINNED TUBE RADIATION (H-2)

.1 Heating elements: NPS 32 mm (1 1/4") seamless copper tubing, 1.2 mm (18 gauge) minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 100 mm x 100 mm (4" x 4") nominal, 164 fins per meter (50 fins/ft) suitable for sweat fittings.

.2 Element hangers: cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm (36") centres maximum.

.3 Standard enclosures: 450 mm (18") high, 1.6 mm (16 gauge) thick steel complete with stamped grille, components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces to be flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Joints and filler pieces to be clear of grilles located to provide easy access to valves and vents. Provide access doors for valves. Finish cabinet with factory applied baked paint coat. Enclosure height as indicated. Sloping top, sloping bottom.

.4 Special enclosures: as indicated.

.5 Dimensions for enclosures: measure site conditions. Do not scale from drawing.

.6 Provide for noiseless expansion of all components.

.7 Expansion compensators: Flexonics at each section by mechanical contractor as specified elsewhere.

.8 Acceptable Manufacturers:

.1 Engineered Air WF-1B Series

.2 Slant Fin

2.5 FINNED TUBE RADIATION (H-3)(ELEMENT WITHOUT ENCLOSURE)

.1 Heating elements: NPS 32 mm (1 1/4") seamless copper tubing, 1.2 mm (18 gauge) minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 100 mm x 100 mm (4" x 4") nominal, 164 fins per meter (50 fins/ft.) suitable for sweat fittings.

.2 Element hangers: cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm (36") centres maximum.

.3 Provide for noiseless expansion of all components.

.4 Expansion compensators: Flexonics at each section.

.5 Coordinate installation of heating elements with millwork.

.6 Acceptable Manufacturers:

.1 Engineered Air

.2 Slant Fin

.3 Sigma

.4 Rittling

2.6 CABINET CONVECTORS (H-4)

.1 Heating element: seamless copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins and cast iron headers, steel side plates and supports.

.2 Cabinet: type as indicated, 1.6 mm (16 gauge) thick steel back and ends,manual damper, exposed corners rounded, secured removable front panel, braced and reinforced for stiffness. Provide stamped grill in sloping top, open bottom. Provide damper and operator and access doors for valves. Finish cabinet with factory applied baked paint coat.

.3 Catalogue rating: certified IBR ratings.

.4 Capacity: as indicated.

.5 Acceptable Manufacturers:

.1 Engineered Air C-1W

.2 Slant Fin

.3 Sigma

2.7 CABINET UNIT HEATERS (H-5)

.1 Cabinet: semi-recessed installation as indicated, 1.6 mm (16 gauge) thick steel with rounded exposed corners and edges, removable panels, glass fiber insulation and integral stamped air outlet and inlet, Arrangement 20

.2 Finish with factory applied primer coat.

.3 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa (145 psi).

.4 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

.5 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.6 Filters: removable permanent washable type.

.7 Capacity and orientation as indicated.

.8 Control:

.1 3 speed switch with integral overloads in cabinet.

.2 Low limit aquastat strapped on to hot water heating supply set to prevent fan operating below 27°C (81°F).

.3 Control thermostat: electric, rated to suit cabinet heater, with setpoint locking device and concealed adjustment.

.1 Remote thermostat and locking guard cover on downflow units.

.2 Integral thermostat with access door on upflow units.

.3 Remote thermostat and guard by BAS contractor.

.9 Acceptable Manufacturers:

.1 Engineered Air CUH Series

.2 Slant Fin

.3 Sigma

.4 Dunham-Bush

2.8 CABINET UNIT HEATERS (RECESSED IN CEILING) (H-6)

.1 Cabinet: Recessed installation as indicated, 1.6 mm (16 gauge) thick steel with rounded exposed corners and edges, removable panels, glass fiber insulation and integral stamped return and supply air outlet, Arrangement 24.

.2 Finish with factory applied primer coat.

.3 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa (145 psi).

.4 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

.5 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.6 Filters: removable permanent washable type.

.7 Capacity and orientation as indicated.

.8 Control:

.1 3 speed switch with integral overloads in cabinet.

.2 Control thermostat: by BAS contractor

.9 Acceptable Manufacturers:

.1 Engineered Air CUH Series

.2 Slant Fin

.3 Sigma

.4 Dunham-Bush

2.9 HORIZONTAL UNIT HEATERS

.1 Casing: 1.6 mm (16 gauge) thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.

.2 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 MPa (145 psi).

.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 louvres.

.6 Capacity: as indicated.

.7 Control: room thermostat: electric, line voltage, locking cover, set point locking device, concealed adjustment, plastic cover. (By Building Automation Contractor).

.8 Acceptable Manufacturers:

.1 Engineered Air H-Series

.2 Slant Fin

.3 Sigma

.4 Dunham-Bush

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Install in accordance with piping layout and reviewed shop drawings.

.3 Provide for pipe movement during normal operation.

.4 Maintain sufficient clearance to permit performance of service maintenance.

.5 Check final location with Consultant if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Consultant's directive.

.6 Valves

.1 Install valves with stems upright or horizontal unless approved otherwise.

.2 Install isolating gate valves on inlet and balancing valves on outlet of each unit.

.7 Venting:

.1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.

.2 Install standard air vent with cock on continuous finned tube radiation.

.8 Clean finned tubes and comb straight.

.9 Install flexible expansion compensators as indicated.

.10 Mount wall mounted convectors at 200 mm (8") above finish floor.

.11 Mount wall mounted radiation at 200 mm (8") above finish floor unless otherwise indicated.

.12 On units fed from below floor provide factory manufactured piping shrouds on the exposed piping between base of the radiation cabinet and finished floor. Shroud shall be manufactured by the radiation manufacturer. Shroud shall match finish of the radiation cabinet.

.13 On fan forced units set discharge patterns and fan speeds to suit requirements prior to acceptance.

.14 Provide new filter media.

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 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.2 Indicate:

.1 Equipment, capacity, piping, and connections.

.2 Dimensions, construction details, recommended method of installation with proposed steel support.

1.2 MAINTENANCE DATA

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

1.3 SAMPLES

.1 Submit samples in accordance with general requirements.

1.4 QUALITY ASSURANCE

.1 Panels shall be manufactured by a company regularly engaged in the manufacture of radiant panels and having catalogue performance data and certified test data.

Part 2 Products

2.1 LINEAR RADIANT CEILING PANELS

.1 Contractor shall refer to architectural reflected ceiling plans and room finish schedule in addition to mechanical drawings to determine location, quantity and finish of radiant panels.

.2 This panel specification is based on the AIRTEX HEF-2 Linear radiant ceiling panel design. Refer to the contract drawings for details and dimensions. Panels shall run continuously from wall to wall or as indicated and specified widths are minimum allowable.

.3 Radiant ceiling extrusions shall consist of extruded aluminum with copper tubing of 15 mm (1/2”) I.D. mechanically attached to the aluminum faceplate. The copper tube shall be held in place by an aluminum saddle, which extends more than half way around the diameter of the tube. A non-hardening heat conductive paste shall be placed between the copper tubing and the aluminum faceplate. Panels shall weigh no more than 10.5 kg/m² (2.15 lb/ft²) when operating. The use of adhesive and/or clips to attach the copper tube to the extrusion will not be acceptable.

.4 Panels shall be finished in the manufacturer’s standard white colour.

.5 Acceptable Manufacturers:

.1 Airtex HEF-2

.2 Epsilon

.3 Frenger

.4 SUN-EL ELF-2 Series

.5 Sigma

.6 Armstrong Airtite

2.2 CAPACITY

.1 As indicated, based on 60ºC (140ºF) average water temperature, 11Cº (20Fº) temperature drop and 18.3C (65ºF) E.A.T.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions and as indicated.

.2 Install in accordance with piping layout and reviewed shop drawings.

.3 Provide for pipe movement during normal operation.

.4 Maintain sufficient clearance to permit performance of service maintenance.

.5 Check final location with Consultant if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Consultant's directive.

.6 The Mechanical Contractor shall co-operate with other trades working in the ceiling to achieve a neat, well co-ordinated overall installation. Refer to Architectural and Mechanical Details for installation requirements.

.7 All interconnecting of radiant panels by the mechanical contractor shall consist of 0.500” O.D. soft copper tubing or accessories as recommended by the manufacturer, i.e. factory supplied 360 deg. Inter-connecting loops and 180 deg. Return U-bends. Multiple panels shall be circuited to ensure serpentine flow over complete length of zone. Individual serpentine panel coils connected in series are unacceptable for multiple panel zones.

.8 All radiant panels shall be field trimmed to length ensuring adequate expansion allowance while maintaining panel end coverage by architectural mouldings. Inactive filler panels will be permitted only where indicated on drawings.

.9 Ceiling support mouldings for Radiant Panels to be supplied and installed by general trades. Ensure ceiling openings and wall mouldings are installed as per radiant panel shop drawings.

.10 All radiant panels shall be installed by personnel wearing clean white gloves, to avoid spoiling of panel face.

.11 Provide hanger wires for safety and/or seismic restraint at 1.2 m (4'-0") o.c.

.12 All active panels shall be covered with a minimum of 50 mm (2") foil backed thick batt non-combustible insulation. Seal edges/entire of perimeter of insulation to radiant panel with foil tape.

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 GENERAL NOTE

.1 This Section is to be read in conjunction with Division 1, the General Conditions and Section 20 02 51, the General Requirements of the Mechanical Trades, and the documents required by the BIDDING REQUIREMENTS and CONDITIONS OF THE CONTRACT sections.

.2 All pricing shall be in accordance with Catholic School Board Services Association (CSBSA) Agreement.

.3 All pricing submissions shall include the following supporting documents; Detailed List Summary, Poteau Analysis, Project schedule and summary letter.

.4 The controls (BAS) contractor will work for the Owner.

.5 **GENERAL**

.1 The work shall include design, supply, installation, and commissioning a complete microprocessor based automatic control system to achieve the performance specified in the following clauses.

.2 The control system shall be installed by the control subcontractor but as an integral part of the mechanical sub-contract. The system shall be installed by trade certified electricians regularly employed by the control sub-contractor.

.3 The controls contractor will specifically read all mechanical and electrical drawings, specifications, and addenda and determine the controls work provided by the mechanical contractor, his subcontractors, and the electrical contractor. The controls contractor is expected to have the expertise to coordinate the work of other contractors and to make a completely coordinated Building Automation Control System (BAS) for the mechanical systems. The controls specifications are specifically written to coordinate the mechanical and electrical systems. Where others are specifically specified to allow for controls work, then the BAS contractor will not allow for that work. This clause is not intended to make the controls contractor responsible for work not specified, but to make the BAS contractor responsible for examining the specifications for contradictions and overlap.

.4 All work indicated in the plumbing drawings and associated with the fire protection or plumbing systems will be the responsibility of the mechanical contractor unless specifically indicated in the controls sequence of operation or points list.

.5 The BAS contractor shall provide the necessary engineering, installation, supervision, commissioning and programming for a complete and fully operational system. The contractor will provide as many trips to the job site for installation, supervision, and commissioning as are necessary to complete the project to the satisfaction of the consultant and/or school board project supervisor.

.6 The system shall consist of all operator interfaces, microprocessor-based controllers, sensors, wells, automatic control valves, control dampers, transducers, and relays, automatic control valves, and damper actuators.

.6 **SCOPE**

.1 This project scope shall include, but not be limited to, the following work:

.1 Preparation of control shop drawings for review and approval. See Submittals.

.2 Supply and install a network of Building Automation Control System (BAS) panels and field devices. See Hardware, Software and Field Devices.

.3 Supply and install customized graphics software to the school board standards, system software, and third party software as specified. See Software.

.4 Install, wire, and label all BAS control system components. See Installation.

.5 Calibrate and commission the installed control system. See Commissioning.

.6 Provide maintenance manuals and as-built drawings. See As-Built Documentation.

.7 Provide customized training for school board operations, maintenance, and technical staff. See Training.

.7 **APPROVED SYSTEMS**

.1 Bids for the BAS contract will be tendered separately by the school board.

.2 Bidders: Johnson Controls, Siemens

.8 **SUBMITTALS**

.1 Submit the six (6) copies of following information to the consultant and/or the school board project supervisor for review and approval:

.2 Control Schematics

.3 Detailed sequence of operation for each control schematic or controlled system.

.4 System Architecture indicating the proposed interconnection and location of all BAS panels, network connections and key peripheral devices (workstations, modems, printers, repeaters, etc.)

.5 BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e., AO/DO/AI/DI), end device fail position, end device manufacture and model number, and wire tag ID).

.6 Wiring diagrams including complete power system, interlocks, control, and data communications.

.7 Manufacturers' data / specification sheets for all material supplied.

.9 **RELATED WORK**

.1 Unless otherwise specified, the following work shall be furnished by others:

.1 The mechanical sub-contractor shall provide:

.1 Water treatment system mechanical wiring.

.2 The BAS contractor shall provide:

.1 Boiler mechanical wiring

.2 DX-cooling solenoid interlock

.3 AHU freeze stats and high limit

.4 Remote VFDs alarm interlock

.3 The mechanical sub-contractor under the supervision of the controls subcontractor shall provide:

.1 Installation of control dampers including duct transitions, assembly, and inter-connection of multiple section dampers.

.2 Supply and installation of sheet metal baffles as required to eliminate air stratification.

.3 Supply and installation of access panels for service and installation of control equipment.

.4 Installation of automatic valves, wells, flow switches, and other pipe related control devices.

.10 **SYSTEM HARDWARE**

.1 The system architecture will be comprised of an Operator Workstation, PCUs (Primary Control Units), PACs (Programmable Application Controllers) and ASCs (Application Specific Controllers) networked together to provide a system of connected controllers that operate as a single BAS for the entire project.

.2 Supply PCU's, PAC's and ASC's as required to interface to all specified equipment.

.3 Allow minimum 25% spare program and trend memory capacity in each PCU and PAC.

.4 Primary Control Units (PCU)

.1 Use only Primary Control Units namely Reliable Mach-Global, Mach 2 or Mach 1 to directly control any major mechanical equipment. Major mechanical equipment includes air handling units, boiler plants, chiller plants, cooling towers and other critical equipment.

.2 Every installation shall have a minimum of one (1) Reliable Mach-Global Panel.

.3 Each PCU shall provide an RS-232 port for direct connection to a PC.

.4 Each PCU shall contain a real time clock and sufficient memory to store its own application database, operating parameters, user programs and trend data storage.

.5 Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours to eliminate operating data reload in case of power failure.

.6 Each PCU output shall include a Hand/Off/Auto (HOA) selector switch for all analogue and digital outputs used to control major equipment as described above.

.7 Each PCU shall have a minimum of 10% spare input channels and 10% spare output channels installed onboard the panel and ready for connection at the completion of the project.

.8 The PCU shall have a minimum of eight (8) inputs and eight (8) outputs.

.5 Programmable Application Controllers (PAC)

.1 PACs are fully programmable controllers namely Mach 1 panels, used for controlling distributed equipment such as radiation, reheat coils, exhaust fans and other distributed equipment. PACs interface to the Primary Control Units via on a sub-network.

.2 PACs shall not be used for controlling major mechanical equipment as described above.

.3 Each PAC shall contain a real time clock and sufficient RAM to store its own application database, operating parameters, user programs and trend data storage.

.4 Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours to eliminate operating data reload in case of power failure.

.5 Each PAC output shall include a Hand/Off/Auto (HOA) selector switch for all analogue and digital outputs used to control major equipment as described above.

.6 The PAC shall have a minimum of eight (8) inputs and eight (8) outputs.

.6 Application Specific Controllers (ASC)

.1 Application Specific Controllers are pre-programmed controllers namely Reliable Mach-Air panels, used to control typical equipment such as rooftop units.

.2 ASCs shall not be used to control major mechanical equipment or non-typical equipment.

.7 Operator's Work Station

.1 Supply licenses for all supplied software directly to the School Board Project Supervisor.

.2 Client-server workstation software is existing and located at the board office. The existing server hosts all the data for the system, while browser clients access provides user interface to restricted data as needed for monitoring and management of each building system. The server workstation shall be updated to include new building system.

.8 System Remote Access

.1 WAN Access

.1 Provide necessary interface and cabling to connect the BAS to the school board WAN. Obtain the particular WAN system details from the Engineer or School Board Project Supervisor.

.2 WAN IP address to be supplied by the school board.

.2 Alarms

.1 Provide and wire a dedicated input to monitor alarming and disarming of the building security system.

.3 Local PC Ports (RS-232)

.1 Where BAS points (4 or more) are located in a mechanical room that does not have a local BAS panel installed, a remote serial port connector (9-pin female) shall be provided to allow for local interface to the BAS via the portable maintenance interface.

.2 Mount the serial connector in a hinged metal enclosure with key-lock set and lamicoid ID label.

.11 **SYSTEM SOFTWARE**

.1 Operators Workstation Software and Graphical Interface

.1 The Operators Workstation software shall be the latest version of the manufacturer's product (RC-Studio) and original software disks / CD's shall be provided to the school board.

.2 The software shall provide access to all controllers, points programs, and systems.

.3 The Graphical User Interface shall be installed and dynamically updated.

.4 The Graphics shall be installed as per the school board standards specified in section 15900-16 of this document.

.2 Trend Data

.1 Provide trend logs for every hardware input and output.

.2 All trends should be accessible via the graphical interface.

.3 Trends should contain all related variables of a control loop (i.e. setpoint, measured variable and control output) and have the ability to be plotted simultaneously on the same graph. Field Devices Individual trends should provide an appropriate "snapshot" of the variable. Slow reacting variables such as space temperatures should be sampled every 30 - 60 minutes while other variables such as mixed air or boiler water temperatures should be sampled every 5 to 10 minutes. Trends should contain a minimum of 72 hours worth of trend data.

.4 The primary input sensor for all control loops must connect to the same panel containing the control loop output.

.5 Trend data storage must be in the same panel as the hardware or logical points being trended.

.3 User Access

.1 The remote connection to the BAS will be configured to allow for the same user commands and functionality as the local front-end connection. The modem connection will allow a remote user to perform panel database uploads/downloads on all BAS panels in the system.

.2 The system will be configured so that a remote user (dial-in or LAN) and local user can be logged onto the BAS simultaneously, and be able to access all controllers, points, and programs in the system.

.4 Alarms

.1 The BAS will be configured to provide for remote alarm capabilities. The BAS shall be capable of dialling out to a minimum of three separate telephone numbers. Designated alarms will be capable of being sent to one or more telephone numbers.

.2 Alarms will be sent in ASCII text format.

.3 The controls vendor will verify that the designated remote workstation successfully receives a series of test alarms

.4 Provide and wire a dedicated output to interface to a designated building security/surveillance. This output will be programmed to initiate.

.12 **FIELD DEVICES**

.1 Automatic Control Valves

.1 Submit a valve schedule for all valves supplied under this contract. The valve schedule will contain the following information for each valve:

.2 Valve type, size, manufacturer, model number, flow coefficient, design flow, pressure drop across valve, max. close-off pressure, actuator manufacturer and model number and maximum torque.

.3 Zone valves shall have a design pressure drop of approximately 1.0 psi. HVAC control valves shall have a design pressure drop between 3 and 5 psi. The minimum allowable CV shall be 0.8 regardless of pressure drop.

.4 Valves used for throttling applications shall have a linear percentage-to-flow characteristic.

.5 Ball valves are the preferred valve type for zone and HVAC control valves. Globe and butterfly valves shall be used where required to provide the desired pressure drop and CV.

.6 Automatic Control valves shall be manufactured by Belimo.

.2 Control Valve Actuators

.1 Size control valve actuators to provide a tight close off against system head pressures and pressure differentials.

.2 Valve actuators shall accept a 0-10VDC control voltage for all proportional applications.

.3 Floating-point control of valves are not acceptable under any circumstances.

.4 Heating valves shall spring-return fail open and cooling valves shall spring-return fail closed. Non-spring-return control valves may be used for terminal reheat coils and large HVAC control valves requiring a higher close off pressure.

.3 Damper Actuators

.1 Actuators shall be direct coupled for either modulating or two-position control. Actuators shall be powered by an overload-proof synchronous motor. Provide 0-10 VDC control voltage for all proportional applications and either line or low voltage actuators for all two-position applications.

.2 Damper actuators are to be manufactured by Belimo.

.3 Duct temperature sensors shall be installed in the airflow down stream of every duct mounted reheat coil.

.4 Duct temperature sensors shall be installed downstream of all variable air volume boxes with reheat coils installed.

.4 Automatic Control Dampers

.1 All automatic control dampers not furnished with packaged equipment shall be supplied by the controls subcontractor and installed by the sheet metal subcontractor. All dampers in a mixing application shall be opposed blade. Parallel blade shall be permitted in other applications. Dampers shall be a tight closing, low leakage type with replaceable extruded vinyl seals on all outdoor and exhaust applications.

.5 Room Sensors/Thermostats

.1 Mount sensors at a height of 5’-6’’ unless otherwise indicated.

.2 10 k ohm type-3 thermistors only shall be used and shall have end-to-end accuracy +/- 0.3 deg C over the entire operating range.

.3 Provide stainless steel plate sensors for public areas such as stairways, vestibules, lobbies and gymnasiums.

.4 Room sensors will not normally have setpoint adjustment. Provide an external setpoint adjustment only when specified for specific offices or meeting rooms.

.5 Mount thermostats and space sensors as noted on the drawing. Do not mount on outside walls without permission of consultant.

.6 Supply and install heavy-duty thermostats for unit heaters, electric radiation, or fan coil units where specified.

.6 Current Switches (Digital)

.1 Provide BAS status for fan and pump motors using a mosfet type digital switch. Acceptable manufactures are ACI, Enercorp, Greystone and Veris, and Elkor.

.7 Pressure Transmitters

.1 Technical Performance - Solid State design, operating on capacitance principle, with non-interactive fine resolution, zero and span adjustments. End-to-end accuracy +/- 2% of full-scale pressure range, including temperature compensation. 4-20mA or 0-5 VDC output.

.2 Standard of Acceptance – ACI, Enercorp, Greystone, Modus.

.8 Duct Temperature Sensor

.1 Probe - Technical Performance – 10 k ohm thermistor sensor encapsulated in a 200mm long, 6mm OD copper or stainless steel probe. Operating range 0-60 degrees C. End-to-end accuracy +/- 0.3 deg C. Assembly complete with wiring housing and mounting flange.

.2 Averaging - Technical Performance - 10 k ohm thermistor constructed of FT6 plenum rated cable or soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor reporting the average temperature form all individual sensors. End-to-end accuracy +/- 0.3 deg C. Assembly complete with wiring housing and mounting flange. Mount in a zigzag manner to provide continuous coverage of the entire duct cross-sectional area.

.9 Outdoor Air Temperature Sensor

.1 Two outdoor air temperature sensors shall be installed and shall be programmed to check each other for accuracy. In the event of sensor failure the sensor deemed to be accurate should be used to control the systems. The outdoor air sensors shall be located on a north wall if possible and a minimum of three (3) feet from any opening in the building envelope, which could affect the sensor readings. The back face of the sensor enclosure shall be insulated to prevent temperature pick up from the building wall.

.2 Technical Performance, 10 k ohm thermistor -50 deg. C to 50 deg. C in a weatherproof enclosure mounted on north exposure. End accuracy of +/- 0.3 deg C over the entire operating range.

.10 Pipe Temperature Sensor

.1 Well - Technical Performance - 10k ohm thermistor sensor encapsulated in a 6mm OD, 50mm long probe, with screw fitting for insertion into a standard thermowell. Operating range -10 - +100 degrees C. End-to-end accuracy +/- 0.3 deg C over the entire operating range. Comes complete with brass thermowell. Use conductive gel when mounting the sensor in thermowell. Use heat transfer paste when mounting the sensor in thermowell. No surface mount strap on temperature sensors shall be used to monitor fluid temperature unless approved by the engineer.

.11 C02 Detector

.1 Technical Performance – Infrared CO2 monitor c/w 4-20mA or 0-5 VDC output, accuracy of +/- 40 ppm +3% reading.

.2 Standard of Acceptance – Vulcain 90DM4DT-C-2000 duct mount, Vulcain 90DM4ASM wall mount.

.12 Electrical Phase Monitor

.1 Every installation shall include an electrical phase monitor installed on the incoming power supply to the building.

.2 In the event of an electrical phase loss the phase loss monitor shall immediately shut down all electrical motors controlled by the BAS.

.3 If a phase loss is detected the BAS system shall generate an alarm, and the alarm shall be sent to the boards central monitoring station.

.13 Airflow measuring stations required to accomplish the specified control sequence shall be furnished under this section but installed under the sheet metal section. Airflow measuring stations shall be of heavy gauge metal construction, and shall be furnished with an air straightening section with an open face area of not less than 97%.

.1 Each airflow measuring station shall measure airflow by means of a network of static and total pressure sensors factory positioned and connected in parallel to produce an averaged velocity pressure. The measured velocity pressure converted to airflow (CFM) shall have an accuracy within 2% of the full scale throughout the velocity range from 700 to 4,000 fpm when measured under ideal laboratory conditions. The location of stations shall meet manufacturer's guidelines.

.2 The maximum resistance to airflow shall not exceed 0.6 times the velocity head. The unit shall be suitable to withstand temperatures up to 121°C (250°F).

.13 INSTALLATION STANDARDS

.1 Power Sources and Wiring Methods

.1 All wiring line and low voltage shall be installed in EMT conduit unless specifically specified otherwise.

.2 In accessible ceilings wiring from BAS controllers to sensors and actuators, control system network and low voltage wiring only may be installed with yellow jacket LVT cable. Where the ceiling is used as a return air plenum install plenum rated yellow jacket cable instead of LVT.

.3 BX or flex conduit may only be used for the final (approximately one meter) run to controls devices, where the controls equipment is mounted on vibrating machinery.

.4 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with the standards set out in Division 16.

.5 No wire smaller than 18 gauge wire is to be used on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.

.6 All wiring from panels to devices shall be without splicing.

.7 Provide wells for all specified temperature sensors in hydronic piping system. Strap-on sensors may be only be used where a well installation is not possible. Obtain approval of Engineer for the use of strap-on sensors.

.8 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently be switched off.

.9 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line side breakers/fuses for all transformers.

.10 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.

.11 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, roof-top unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.

.12 All BAS control panels shall be provided with UPS in the power supply except for Application Specific Controllers (ASC).

.13 All BAS control wiring shall be yellow jacket for identification purpose.

.14 The breaker or power isolation location shall be clearly marked on the inside door of each BAS panel enclosure.

.2 Equipment Location

.1 All distributed equipment such as VAV boxes, Roof top units, unit ventilators, fan coil units, etc. that utilize dedicated BAS controllers, shall have locally mounted controllers, in accessible locations within the building envelope. All locally mounted controllers shall be installed in enclosures suitable for that location. BAS controllers for mechanical equipment other than those listed above shall be mounted in mechanical rooms as noted below, unless specifically approved by the Engineer for this project.

.2 All other BAS controllers, and interface devices that require regular inspection or that serve multiple HVAC systems shall be located in mechanical rooms, or in pre-approved storage rooms, or janitor closets.

.3 All BAS panels shall be located within the building envelope, and shall be enclosed in a metal locking enclosure, as specified elsewhere herein.

.4 All equipment located in mechanical rooms, storage rooms or janitor closets shall be installed in metal cabinets with hinged, lockable covers. Provide an school board-standard #549 key/lock set for each cabinet.

.5 Transformers or power supplies shall not be located in ceiling spaces unless approved by the engineer for terminal control valves, actuators or zone controllers. When transformers are installed above ceilings, transformers shall be installed in metal enclosures, and the location shall be clearly labelled on the t-bar ceiling to indicate power transformer location.

.6 A 120 VAC duplex receptacle for laptop power shall be provided if the cabinet is located further than 1500 mm (5’) laterally from the nearest outlet.

.14 **IDENTIFICATION AND LABELLING OF EQUIPMENT**

.1 All panels must have a lamicoid tag (min. 3”x1”) affixed to the front face indicating panel designation and function (i.e. “BAS Panel 1” or “Relay Panel 3”).

.2 All field sensors or devices must have a lamicoid tag (min. 3”x1”) attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1_MAT, 2.IP4).

.3 Room sensors and other sensors in finished areas do not require a device tag.

.4 All devices within a field enclosure will be identified via a label or tag.

.5 All BAS panel power sources must be identified by an adhesive label indicating the source power panel designation and circuit number on the outside of the enclosure door (i.e. “120vac fed from LP-2A cct #1).

.6 All field equipment panels fed from more than one power source must have a warning label on the front cover.

.7 All wires will be identified with self-adhesive wire labels or clip-on plastic wire markers at both ends.

.8 All rotating equipment controlled by the BAS will have a tag or label affixed indicating that the equipment may start without warning.

.9 If a phone line manager is supplied, its location should be indicated via a label affixed to the inside cover of the modem enclosure or BAS panel.

.10 All BAS panels will have a points list sheet (within a plastic sleeve) attached to the inside door. The points list will identify the following for each point: Panel number, panel location, hardware address, software name, point description, field device type, point type (i.e. AI or DO), device fail position, device manufacturer and model number or reference and wire tag reference.

.11 Where required, field panels will have wiring diagrams attached to the inside door.

.12 Provide new or modify existing equipment wiring diagrams (i.e. boilers, chillers, etc.) wherever the BAS interfaces to other equipment.

.15 **COMMISSIONING**

.1 Confirm and demonstrate to the Engineer Mechanical Contractor, and the Owner’s agent that that all systems are programmed and operating correctly.

.2 Submit four (4) copies of the system commissioning report to the Engineer for review and approval.

.3 Each analogue inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be with +/- 1C of the readings observed at the workstation.

.4 Each analogue output shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%.

.5 Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.

.6 Digital inputs shall be verified by observing the status of the input point as the equipment is manually cycled on and off.

.7 Record all out-of-season or unverified points in the commissioning report as “uncommissioned”.

.8 The BAS field panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all connected system components should go to their fail-safe state.

.9 All trends should be reviewed to ensure that setpoints are being maintained and excessive cycling of equipment is not occurring.

.10 Control loop-tuning parameters can be verified by applying a change to the current setpoint and observing the resulting trend log. Setpoint should be reached in a “reasonable” period of time without excessive cycling or hunting of the controlled device.

.16 **TRAINING**

.1 The school board staff shall provide training for the building operations staff.

.2 At the completion of the installation and immediately following commissioning provide a ½ day training session on site for the Owner's designated maintenance personnel.

.17 **WARRANTY**

.1 Warranty all components supplied under this contract for a period of one year from substantial completion. Replace all controls equipment that fails during this period without cost to the owner.

.18 **AS-BUILT DOCUMENTATION**

.1 Within two weeks following substantial completion of the project, update the original submittal documents to reflect the "As Built" conditions of the project and submit as many copies as are required by the consultant and/or the School Board Project Supervisor.

.2 Provide a separate laminated copy of the control drawings for mounting in the mechanical room or in the controls panels as directed by the consultant or the School Board Project Supervisor.

.3 Submit diskettes/CD’s (including back-up diskettes/CD’s) containing up to date copies of the programs in each controller. Provide original program disks and documentation proving registration for all software programs provided as a part of this contract including: the BAS operator interface software, and the BAS graphics (Illustrator files & bitmap files). Provide one set of original disks for every computer supplied under this contract or that the software has been loaded onto.

.4 Submit (4) printed copies of the final programs that include all point definitions, weekly and annual schedule setting, controller setpoints and tuning parameters, and documented programmed sequences of operation.

.19 **GRAPHIC DISPLAY SCREENS**

.1 All Graphic Display Screens shall have the following common elements and functions regardless of system manufacturer. Every site shall have a graphic display screen for Site Graphic, System Architecture, each air handler, boilers, emergency generator, lighting, exhaust fans, heat reclaim, and for each room controlled by the BAS system.

The Graphic Display Screens shall follow the format to be consistent with the established School Board BAS Systems as displayed in Appendix "A". All operator accessible points shall be yellow text and all information points shall be blue. The specific screens shall include the following:

.2 Graphic Screens General All Screens

.1 Navigation buttons to each major system in the building which indicate current screen display by a change in button colour

.2 Background colour shall be black

.3 Outdoor air temperature shall be displayed on every graphic screen

.3 Site Graphic

.1 The School Board Logo on the site or opening graphic screen

.2 Artist concept or scanned in picture of the front of the school

.3 Access links to all global schedules or specific screens affecting entire building operation

.4 Access buttons links to Set Time, Holiday Schedule, PD Day Schedule, Alarms, Points on Manual, Conversion °C - °F, 24 Hour Clock, Operations Manual, autocad Drawings, Reliable BAS Manual, and Work Orders.

.4 System Architecture

.1 Control panel layout and network architecture

.2 Indicating BAS panels and panel type (model)

.3 Panel locations

.4 Systems controlled by each panel

.5 Links to points list accessible from each panel

.5 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, as shown in Appendix "A"

.6 Status of Air Handler by colour change Red for off status, or text indication

.7 Supply air temperature for each air handler

.6 Air Handler (AHU) graphic

.1 Accurate representation of the AHU design

.2 All associated control points to be displayed

.3 All points to be monitored for automatic mode and shall be displayed when in Manual mode

.4 A calculated percentage of fresh air shall be indicated on the AHU graphic

.5 Operator offset adjustment of the supply air setpoint, adjustable directly form the graphic

.6 AHU physical location shall be indicated on the graphic

.7 Weekly occupied time of day schedule for the associated AHU shall be accessible directly from the graphic by selecting an icon

.8 Weekly student time of day schedule for the associated AHU shall be accessible directly from the graphic by selecting an icon

.9 Trend logs shall be accessible directly form the graphic by selecting an icon

.7 Glycol Heating

.1 Graphic piping layout shall be accurate as per piping layout

.2 All associated control points for the glycol heating system to be displayed

.3 Operator offset adjustment of the scheduled water setpoint, adjustable directly form the graphic.

.4 Lead pump shall be indicated

.5 Pump status shall be indicated graphically

.6 Calculated scheduled water setpoints to be displayed

.7 Operator offset editable directly from the graphic screen

.8 Weekly time of day schedule for the building occupied schedule shall be accessible directly form the graphic by selecting an icon

.9 Trend logs shall be accessible directly form the graphic by selecting an icon

.8 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

.20 **BAS DATABASE NAMING CONVENTIONS AND PROGRAMS**

.1 Miscellaneous Equipment Naming Conventions

.1 Network Status Panel Naming Conventions should indicate the school, panel location and panel number. The school name can be abbreviated as necessary to fit in the space.

INPUTS		***OUTPUTS***	
Equipment	***Point Name***	***Equipment***	***Point Name***
Exhaust Fan Status	*EF # Status*	*Exhaust Fan Control*	*EF # Control*

.21 **INTEGRATION WITH THIRD PARTY MANUFACTURER'S EQUIPMENT**

.1 Any additional integral control systems included with the products integrated with the work of this section shall be furnished with a BACnet MSTP interface for integration into the Direct Digital Control System described in this section. Open system protocol shall be maintained, and no proprietary equipment will be allowed to successfully complete any third party integrations. The controls contractor is responsible for all programming necessary to seamlessly integrate this third party equipment to the BAS. The controls contractor is responsible for providing device addresses for all devices that are going to be integrated to the BAS, such that no device communication issues will arise. The controls contractor is responsible for any meetings, correspondence or communication required with the third party equipment suppliers in order to successfully integrate the equipment to the BAS.

1.2 RELATED WORK

.1 Supply all necessary efforts to provide the project DDC system as specified.

1.3 DESCRIPTION OF SYSTEM

.1 This is a complete removal of an existing DDC control system. Supply & install a complete new DDC control system. Furnish and install all components, devices and control wiring for a fully integrated Energy Management and Environmental Control System incorporating Direct Digital Control (DDC), and equipment monitoring. The system shall control and monitor HVAC equipment, HVAC systems, and other equipment as specified in this section.

.2 Refer to demolition drawings for removal of all existing control devices. All existing exposed pneumatic tubing and equipment which is not reused shall be removed complete. All concealed existing pneumatic tubing shall be abandoned.

.3 Furnish and install all components, devices and control wiring for a fully integrated Energy Management and Environmental Control System incorporating Direct Digital Control (DDC), and equipment monitoring. The system shall control and monitor HVAC equipment, HVAC systems, and other electrical loads as specified in this section. The work shall include but is not limited to the following:

.4 The work shall include but is not limited to the following:

.1 A programmable building automation control (BAS) system

.2 Local/remote system control/monitoring via BACnet/IP TCP/IP Ethernet LAN/WAN connections

.3 Chilled water system control

.4 Indoor Air Handling Unit Control

.5 Rooftop HVAC unit control

.6 Exhaust fan control

.7 Fan coil control

.8 Bypass box control

.9 Receiving room control

.10 Radiation heating control

.11 Unit heater control

.12 Electrical force flow control

.13 Mechanical Room control

.14 Electrical Room control

.15 Machine Room ventilation

.16 Main Lan room control.

.17 Domestic hot water system control

.18 Trap primer solenoid valve control

.19 Phase loss detection

.20 Outdoor lighting control

.21 Hot water boiler system

.22 Utility monitoring

.23 Building low temperature

.24 Connection to fire alarm system

.25 Security system monitoring

.26 Domestic Water Flushing Control

.5 All the necessary controls, valves, motors, control wiring, conduit, control panels, instrumentation, computer software, and network access units, for the specified system shall be provided under this section. The installed system shall incorporate electronic and digital control devices to perform the control sequences and programs outlined herein. Specific control sequence requirements are as detailed in subsequent sections of this specification and on the drawings.

.6 All electrical wiring, mechanical installations, and control sequences shall comply with local and provincial electrical and mechanical codes.

.7 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.

1.4 ASSOCIATED WORK SPECIFIED IN OTHER SECTIONS

.1 The contractor shall coordinate the installation of devices furnished in this section with the installing contractor by trade jurisdiction.

.2 Heating Contractor

Install all valves, valves, wells etc. as shown on drawings

.3 Sheet Metal/Ventilating Contractor

Install all single and multiple section dampers, interconnecting linkages, blank-off plates, duct transitions, access doors, louvers, and similar items as required for the system and/or as indicated on the drawings.

.4 Electrical Contractor

Install and connect electrical power to all motors, transformers, and starters. A power supply will be available from the panel in the mechanical room for DDC system control panels.

1.5 SYSTEM ACCEPTANCE

.1 System commissioning and interface to facilities management network shall be performed by the Building Automation contractor.

.2 On project completion, the contractor shall issue a report to the consultant stating that the system is complete, that all hardware and software functions have been verified and that the system is operating in accordance with the specifications. A demonstration of complete system operation shall then be made to the owner's authorised representative.

.3 Upon successful completion of the system demonstration, the owner's representative shall be requested to approve, in writing, the satisfactory operation of the DDC System, interface devices and accessories.

.4 The consultant shall verify through the owner’s representatives that the entire system is complete and operating to the satisfaction of the owner before final acceptance is approved.

1.6 MAINTENANCE DATA AND SERVICE

.1 Provide maintenance data for controls and instrumentation for incorporation into maintenance manual.

.2 After acceptance, seasonally check and readjust control systems for change over. Make 2 site trips. Notify Engineer of scheduled dates. Carry out any preventive maintenance required including parts and labour. Report to Engineer, in writing, results or resetting made.

.3 Provide as-built information in accordance with Section 15010, requirement.

1.7 TESTING AND BALANCING

.1 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.

Part 2 Products

2.1 ELECTRIC AND MECHANICAL DEVICES

.1 All electric switch devices shall be selected for the applied load and UL listed and labeled for the application and environment to which they are applied. Miscellaneous, electric, and mechanical devices shall include:

.2 Provide any automatic control dampers not specified to be integral with other equipment. Frames shall not be less than 2.5 mm (13 gauge) galvanized steel. Blades shall not be over 200 mm (8") wide nor less than 1.6 mm (16 gauge) galvanized steel roll formed. Bearings shall be oilite, ball bearing or nylon with steel shafts. Side seals shall be stainless steel of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of –40°C to 93°C (-40°F to 200°F).

.1 All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.

.2 Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 150 mm (6").

.3 Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all control dampers with the temperature control submittal. Maximum leakage for dampers in excess of sixteen inches square shall be 152 l/s/m^2 (30 cfm/ft^2) at static pressure of 25 mm (1") of w.c.

.4 Where ultra-low leakage dampers are specified the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 2.8 l/s/m^2 (6 cfm/ft^2) for dampers in excess of sixteen inches square at 25 mm (1") of w.c.

.3 Automatic control valves 65 mm (2½") and smaller shall be screwed type, and valves 80 mm (3") and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packaging with replaceable discs.

.1 All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position. Valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 34 kPa (5 psi).

.2 Unitary valves shall provide precision flow control of hot or chilled water in various heating or cooling applications. The unitary valves shall consist of a valve body and replaceable characterized cartridge assembly and shall be compatible with a valve actuator that meets the requirements of UL94-5V fire retardancy for mounting in return air plenums. The actuators shall have conformally coated printed circuit boards for humidity resistance.

.3 The actuators shall de-energize when the valve is not in motion to extend service life. The unitary valves shall provide proportional flow in modulating, diverting or mixing applications. They shall operate silently and resist water hammer.

.4 The unitary valve and actuator assembly shall be equipped with a manual opener and position indicator.

.4 All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. All actuators (valves, dampers etc.) shall be by this contractor.

.5 Acceptable material:

.1 Belimo

Part 3 Execution

3.1 GENERAL

.1 The DDC controls project shall be performed in accordance with the general conditions of the contract. The contractor shall conduct all on-site work in conjunction with building operating staff to streamline the new system startup.

.2 The summary of input/output channels describe the DDC system points. It is the responsibility of the Contractor to ensure compatibility of the mechanical systems, devices, and actuators with the DDC system.

.3 All digital output control points located in unconditioned spaces shall be relocated to an accessible ventilated indoor location. All control devices, DDC panels; other shall be located inside the conditioned space of the building envelope.

.4 All DDC system equipment will become the property of the Owner.

3.2 ON SITE TESTING

.1 Provide Engineer-approved operation and acceptance testing of the complete system. The Consultant/Owner will witness all tests.

.2 Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. The installer shall complete all testing, calibrating, adjusting and final field tests. Provide a detailed cross-check of each sensor within the system by making a comparison between the reading at the sensor and a standard traceable to the National Bureau of Standards.

Provide a cross-check of each control point within the system by making a comparison between the control command and the field-controlled device. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. Submit the results of functional and diagnostic tests and calibrations to the Engineer for final system acceptance.

.3 Compliance Inspection Checklist: Submit in the form requested, the following items of information to the Owner's Representative and Consultant for verification of compliance to the project specifications. Failure to comply with the specified information shall constitute non-performance of the contract. The contractor shall submit written justification for each item in the checklist that he is unable to comply with. The Owner's Representative and the Consultant will initial and date the checklist to signify contractor's compliance before acceptance of system.

.1 Verify to the Owner's Representative and Consultant in letterform 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.

User Date Consultant Date

.2 Manually generate an alarm at a remote DDC Controller as selected by the Consultant to demonstrate the capability of the workstation and alarm printer to receive alarms within 5 seconds.

User Date Consultant Date

.3 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.

User Date Consultant Date

.4 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 Consultant.

User Date Consultant Date

.5 At a DDC Controller of the Consultant’s choice, display on the portable operator's terminal:

.1 At least one temperature set point and at least one status condition, i.e., on or off for a system or piece of equipment attached to that panel as well as for points at another DDC Controller on the network.

.2 The diagnostic results as specified for a system or piece of equipment attached to that panel as well as for a system or piece of equipment attached to another DDC Controller.

.3 The ability to add a new point to the DDC Controller with the POT and have it automatically uploaded to the workstation to modify that panel's stored database.

User Date Consultant Date

3.3 INSTALLATION

.1 Install systems and related controls in accordance with approved shop drawings and manufacturer's recommendations using factory-trained journeymen certified by the Province of Ontario.

.2 Locate room sensors, etc., at height and as required per Ontario Building Code.

.3 Secure approval for damper motor locations and supports. Submit detail of damper motor location and support for approval.

.4 Provide dampers, for installation by the sheet metal contractor.

.5 Provide valves for installation by the piping contractor.

3.4 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.

3.5 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 and refrigerant leak system specific ventilation systems.

.6 De-energize any other potential sources of ignition within the affected system.

3.6 POINT DESCRIPTORS

.1 Adopt and utilize a consistent naming convention in order to identify points and facilitate wild-card calling of all points, systems, and programs to the standards of the school board.

3.7 SYSTEM OPERATION

.1 General

Where Optimum Start Stop (OSS) is specified, equipment shall start-up based on global outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy time (occupancy schedules are defined under time programs) and operate in both heating and cooling cycles. In all cases, the optimum start program shall operate fully stand-alone in the local GPC.

OSS shall include a Night Cycle program applying to (heating cycle only) (both heating and cooling cycle) with the outdoor air dampers closed. The space temperature shall be used to determine the “fan on” and/or “supply heat” command to maintain a low limit of *50-55* degrees for the heating cycle and the “fan on” and “supply cooling” command to maintain 82 degrees for the cooling cycle.

Where an Economizer Cycle (EC) is specified, it shall automatically enable the economizer mode based upon an enthalpy comparison of outdoor air and return air of each AHU.

.2 Data Control (D/C) and Graphics Summary

All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators, and flow meters required to provide the control and graphic data described. Provide software setpoints required for display in logical groups and graphics.

Each digital output shall have a software-associated monitored input. Any time the monitored input does not track it’s associated command output within a programmable time interval, a “command failed” alarm shall be reported.

Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups.

Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

In addition to the Unitary DDC Controller data points specified to be presented on colourgraphic displays, technical data for each zone mechanical apparatus shall be presented to operators on the OWS in full English menu text displays including the apparatus name; heating and cooling PID loop P, I and D gains; primary CFM airflow (if measured); damper position (% open); reheat status/value; cooling setpoint; heating dead-band; minimum and maximum CFM setpoints; reheat CFM setpoint; unoccupied temperature setpoint; temperature sensor calibration offset; bypass push button time, in minutes; smoke purge mode damper position; smoke pressurization mode damper position; smoke depressurization mode damper position; and morning warm-up mode damper position. All such points shall be presented in complete and direct read-write (command) format unless they are provided in commandable colourgraphic displays.

In addition to Graphics of building systems with dynamic data points as noted in the following Data and Control and Graphic Summary, the following additional graphics shall be provided:

.1 Facility layout (showing buildings, streets, etc.)

.2 Individual area layouts or isometrics

.3 Any other graphics necessary for logical penetration

.4 Individual HVAC systems graphics

.5 Sequences of operation

.6 Flowcharts for critical DDC loops

.7 Supervisor graphics

.8 System configuration

.3 Application Requirements

.1 Software

The microprocessor-based control system shall rely on software for non-critical interlocks and time delays. Where required by the specifications, these functions shall be provided by separate thermostats, relays, and delay timers.

.2 Interlocks

Safety and other interlocks may require relays depending on the specific devices being used. Some devices may require a special power supply as shown in the wiring details. Safeties shall be hardwired into the control circuit and shall also be monitored by the BMCS.

.3 Sensors

Select duct insertion sensors to suit the application. For large ducts, use sensors with longer probe lengths. For heating and cooling coil freeze protection, use a long capillary type sensor. For mixed air and coil discharge temperature sensing, use averaging capillary type sensors.

.4 Valves

Ensure that actuators meet all the job requirements (i.e., control signal, close off, action, etc.). Control valves shall be selected to suit both the medium and the specified configuration (i.e., Straight-thru, 3-way, screwed, flanged, etc.).

.5 Damper Actuators

The total number of actuators may vary depending on the damper size. Consult the actuator's application literature to determine sizing requirements and use no less than 30% of the minimum number of actuators recommended.

.6 Graphics

The system graphics shall include operator control panels to facilitate working with the AHU:

.1 The Warm-up Panel shall permit the operator to monitor the status of the warm-up mode (on or off), and to change the setpoint of the warm-up temperature.

.2 The Unoccupied Cycle control panel shall permit the operator to monitor the status of the mode (occupied or unoccupied), and to change the unoccupied periods setpoints.

.3 The Mixed Air Dampers control panel shall permit the operator to monitor the economizer mode (on or off), monitor the damper position, and to change the minimum position setpoint.

.4 The Optimum Start/Stop control panel shall permit the operator to monitor and change optimum start/stop program parameters.

.5 The Reset Schedule control panel shall permit the operator to monitor and change reset schedule program parameters.

It is not acceptable to monitor and change these modes of control in a manner other than that specified. Having to edit, compile and reload application programs to achieve monitoring and control of these modes is not acceptable.

.6 Provide the text of the control sequence so that it may be displayed on the operator screen by clicking on the Sequence control button on the system graphic. The sequence will incorporate all parameter values and setpoints, and will update them dynamically as they change or are changed.

.7 Graphic Display Screens

.1 All Graphic Display Screens shall have the following common elements and functions regardless of system manufacturer. Every site shall have a graphic display screen for Site Graphic, System Architecture, each air handler, boilers, emergency generator, lighting, exhaust fans, heat reclaim, and for each room controlled by the BAS system. The Graphic Display Screens shall follow the format to be consistent with the established School Board Reliable BAS Systems as displayed in Appendix "A". All operator accessible points shall be yellow text and all information points shall be blue. The specific screens shall include the following:

.1 Graphic Screens General All Screens

.1 Navigation buttons to each major system in the building which indicate current screen display by a change in button colour.

.2 Background colour shall be black.

.3 Outdoor air temperature shall be displayed on every graphic screen.

.4 Site Graphic.

.5 the School Board Logo on the site or opening graphic screen.

.6 artist concept or scanned in picture of the front of the school.

.7 access links to all global schedules or specific screens affecting entire building operation.

.8 access buttons links to Set Time, Holiday Schedule, PD Day Schedule, Alarms, Points on Manual, Conversion °C - °F, 24 Hour Clock, Operations Manual, Autocad Drawings, Reliable BAS Manual, and Work Orders s shown in Appendix “A”.

.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, as shown in Appendix “A”.

.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 Unit Graphic

.1 accurate representation of the HVAC design.

.2 all associated control points to be displayed.

.3 all points to be monitored for automatic mode and shall be displayed when in Manual mode.

.4 a calculated percentage of fresh air shall be indicated on the HVAC graphic.

.5 operator offset adjustment of the supply air setpoint, adjustable directly from the graphic.

.6 HVAC physical location shall be indicated on the graphic.

.7 weekly occupied time of day schedule for the associated HVAC shall be accessible directly from the graphic by selecting an icon.

.8 weekly student time of day schedule for the associated HVAC shall be accessible directly from the graphic by selecting an icon.

.9 trend logs shall be accessible directly from the graphic by selecting an icon.

.6 Boiler Graphic (Glycol Loop Similar)

.1 Boiler graphic piping layout shall be accurate as per piping layout

.2 All associated control points for the boiler system to be displayed

.3 Operator offset adjustment of the scheduled water setpoint, adjustable directly form the graphic

.4 Lead boiler and boiler stages shall be indicated

.5 Lead pump shall be indicated

.6 Boiler status shall be indicated graphically

.7 Pump status shall be indicated graphically

.8 Calculated scheduled water setpoints to be displayed

.9 Operator offset editable directly from the graphic screen

.10 Weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon

.11 Trend logs shall be accessible directly from the graphic by selecting an icon

.7 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.

.4 Design Requirements

.1 Safeties: Smoke detector or high temperature interlocks will be hard-wired to the supply fan starter. These points will be assigned addresses in the DDC controller for alarm annunciation purposes only. AHU's with flows greater than 15,000 CFM will require a smoke detector or high temperature detector in the supply and return air ducts.

.2 Schedules: Time schedules will default to 6AM to 6PM, Monday through Friday.

.3 Actuators: Actuator output points will display as follows:

.1 0% = 2-way valve, closed.

.2 0% = 3-way valve, closed to the coil.

.3 0% = Mixed air dampers, full return air position.

.4 100% = 2-way valve, open.

.5 100% = 3-way valve, open to the coil.

.6 100% = Mixed air dampers, full fresh air.

.7 These requirements shall be the case no matter how the actuator is sequenced or whether it is a reverse or direct acting valve.

.4 Valves: Heating coil valves shall fail open to the coil. Mixed air dampers shall fail to the full return air position.

.5 Outdoor Sensors: Outdoor air temperatures and humidity (where applicable) are assumed to be Global points transferred to DDC controllers. If the BMCS system lacks global point capability, global points shall be replaced by hardware points connected to specific controllers; the I/O capacity of the controller being used must be checked to make sure the added points will fit in the controller and upgraded in point capacity if necessary.

3.8 POINTS LIST

.1 The points list appended here to shall be read in conjunction with the drawings and specification. Should the control functions be indicated in the specification and not indicated on the points list or indicated in the points list and not in the specification, it does not relieve in the contractor in provide a complete system. It is the contractor's responsibility to ensure the BAS system is installed and operates as specified.

3.9 SEQUENCE OF OPERATION

.1 SEQUENCE OF CONTROL

.1 General

.1 The control programs shall be modular and structured in order to provide specific control operation of all HVAC components indicated.

.2 All control programs shall provide a minimum of 20% spare memory for expansion.

.3 Each control program shall contain "REM" statements which explain the program operation.

.4 Each control program shall open with a list of the I/O points used and controlled in the program.

.2 DDC Sensors and Devices - are listed in the Points Summary that is part of this specification. Provide 5% spare I/O capacity.

Implement the following control program concepts in full, or partial as required, to provide complete HVAC equipment control. The programs shall perform all control strategies on the basis of protecting equipment operation, saving operational energy costs, and indicating alarm conditions.

Programs, which increase the system energy consumption or cause equipment failures, will be refused and resolved by the contractor accordingly at not additional cost to Owner.

.3 Where Optimum Start Stop (OSS) is specified, equipment shall start-up based on global outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy time (occupancy schedules are defined under time programs) and operate in both heating and cooling cycles. In all cases, the optimum start program shall operate fully stand-alone in the local GPC.

OSS shall include a Night Cycle program applying to (heating cycle only) (both heating and cooling cycle) with the outdoor air dampers closed. The space temperature shall be used to determine the "fan on" and/or "supply heat" command to maintain a low limit of 50-55 degrees for the heating cycle and the "fan on" and "supply cooling" command to maintain 82 degrees for the cooling cycle.

.4 Where an Economizer Cycle (EC) is specified, it shall automatically enable the economizer mode based upon an enthalpy comparison of outdoor air and return air of each AHU.

.5 System Architecture: The control sequences will be performed by DDC controllers arranged as indicated in the following architecture diagram:

.6 Boiler Graphic (glycol Loop Similar)

.1 boiler graphic piping layout shall be accurate as per piping layout

.2 all associated control points for the boiler system to be displayed

.3 operator offset adjustment of the scheduled water setpoint, adjustable directly form the graphic

.4 lead boiler and boiler stages shall be indicated

.5 lead pump shall be indicated

.6 boiler status shall be indicated graphically

.7 pump status shall be indicated graphically

.8 calculated scheduled water setpoints to be displayed

.9 operator offset editable directly from the graphic screen

.10 weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon

.11 trend logs shall be accessible directly from the graphic by selecting an icon

.2 **DEDICATED OUTDOOR AIR UNIT – MUA-1**

.1 The AHU unit consists of a mixing section with return air, outdoor air dampers, exhaust connection, OA connection, filter sections, energy recover system, glycol heating section, glycol cooling section, hydronic dehumidification, exhaust fan and supply fan. Perimeter radiation is also included as part of this sequence.

.2 In the event of power loss, a disable command, or failure of integral heating system the outdoor air dampers and exhaust air dampers are to close, and fans, heating, cooling and mechanical heat / energy recovery system are to shut-down.

.3 Scheduled Occupancy

.1 *Pre-Occupancy:* The BAS shall enable the supply and return air fans 30 minutes prior to the start of the occupied period. Integral heating or dehumidification is to be enabled and commanded such that a supply discharge air temperature of 18°C is maintained. Modulate bypass damper open. Concluding a run-time of not less than 15 minutes, the return air CO2 value shall be measured. Exhaust fan and/or dampers, when equipped, are to be enabled simultaneously with the supply and return air fans.

.2 *Occupied:* The BAS shall enable / command on the unit to an occupied state which is defined by school occupancy times. If the measured exhaust CO_2 level value is equal to or greater than 800 ppm (adj) an alarm is generated. Integral heating, cooling, dehumidification and energy recovery is to be sequenced to maintain a supply discharge air temperature of 18°C. The exhaust fan and dampers are to be enabled simultaneously with the supply air fan.

.3 *Un-Occupied:* The BAS shall disable /command off the unit to an un-occupied state which is defined by school occupancy times. During the un-occupied state all fans are to be shutdown, the outdoor air dampers, and exhaust air dampers are to be released and close by way of mechanical spring return (0% position).

.4 Discharge Air High/Low Temperature: While in the heating mode with heat stages on, an alarm will be generated whenever the discharge air temperature rises above or drops below the Discharge Air Temperature Heating High or Low limits for a duration of 1 min (adj.).

.5 Fan System Failure Alarm: An alarm is generated whenever the supply and/or exhaust fan fails to respond to start-stop commands. The supply and exhaust air fans are to be controlled by VFD. Status of the fans shall be monitored using a feedback from the drive or an analogue signal from a current transformer.

.6 Freeze Alarm: A freezestat located immediately downstream of the remote heating coil will shut down the HVAC unit and open the three way valve to full flow when it detects a temperature below its setpoint. It will be necessary to reset the freezestat manually.

.7 Discharge smoke detectors in the supply air streams de-energize the supply and exhaust fans upon activation. When the OAT is less than 50 degrees F (10 degrees C), the gas heating valve and dampers modulates to maintain the mixed air temperature at 50 degrees F (10 degrees C).

.8 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.

.9 Provide an airflow station on each supply air ducts and an airflow station and motorized damper on each of the return air ducts to monitor and control return airflow in conjunction with the supply air flow and space pressurization sensor for each space as indicated. The return airflow shall be approximately 95% (adjustable) of the supply air flow.

Name	**AI**	**AO**	**DI**	**DO**
Supply Fan Command				X
Supply Fan Speed Modulation		X		
Supply Fan Status	X			
Supply Fan Alarm			X	
Duct Static Pressure	X			
Return Fan Command				X
Return Fan Speed Modulation		X		
Return Fan Status	X			
Return Fan Alarm			X	
Hot Water Valve Modulation		X		
Chilled Water Valve Modulation		X		
DX Modulation (MUA-1)		X		
Supply Air Flow Volume	X			
Supply Air Temperature	X			
Supply Air Humidity	X			
Return Air Temperature	X			
Return Air CO_2	X			
Return Air Humidity	**X**			
Mixed Air Temperature	X			
Mixed/Return/OA Air Damper Command		X		

Mixed/Return/OA Air Damper Position	**X**			
Freeze Stat Status			X	
ERV Wheel Command				X
ERV Wheel Speed		X		
ERV Wheel Status	X			
ERV Wheel Entering Air Temp	X			
ERV Wheel Leaving Air Temp	X			

.3 **PACKAGED HVAC (CONSTANT VOLUME)**

.1 General

.1 The constant volume air handling units consists of a mixed air section with outdoor air and return air dampers, pre-filter, DX cooling coil, multiple-stage gas heat, and supply fan. The unit is DDC controlled using electric actuation.

.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 Unit Start/Stop

.1 Occupied Mode: unit fan runs continuously.

.2 Unoccupied Mode: unit fan is off unless there is requirement for space heating and cooling.

.4 Control Strategy

.1 Space Temperature Control

.1 Room Temperature Control: The gas heat and DX cooling stage(s) will be activated appropriately to maintain the supply air temperature at its setpoint.

.2 Unoccupied Mode: When the room temperature falls below the unoccupied low limit setpoint, then the HVAC unit will start and continue to run until the room temperature rises by 3C°. If the room temperature rises above the unoccupied high limit setpoint, then the unit will start and continue to run until the room temperature falls by 3C°. Unit shall operate at full heat or cooling to bring space to setpoint as quickly as possible. Provide minimum run times as per Occupied mode. If supplemental heat is available, it shall be first stage heat.

.3 Morning Warm-up: When the HVAC unit starts-up after the unoccupied period and the return air temperature is below the warm-up mode setpoint, 20°C (adj.), the warm-up mode is in effect. The outdoor air damper will close fully and the gas valve will open until the return air temperature exceeds warm-up mode setpoint. Cooling stages will be locked-out during the warm-up mode.

.2 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.

.3 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.

.4 Ventilation Control

.1 Provide CO_2 controls connected to the unit to override OA damper controls to allow more outside air to enter. Maintain CO_2 at 1000 ppm (adj). Limit outside air in order to prevent MAT falling below 13 degrees C.

.2 Outside air damper shall be open to minimum position during occupied mode and closed in unoccupied mode.

.5 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 2 Speed Control: When there is no call for heat/cool, the fan is at 67%. Unit will control to space temperature setpoint as sensed by the thermostat. On call for heating, fan is 100%. On a call for cooling, above 50% cooling demand, fan is 100%.

.6 Override: Provide a 3 hour override button on thermostat to change unoccupied period to occupied. BAS can schedule units off.

Supply air low limit control shuts down fan system if SA-T drops below 5°C, software reset is required.

.7 Night Cycle: Should temperature still drop below setpoint HVAC unit will energize in heating mode until setpoint is reached then shut off.

.8 Provide software logic to shut down all fan systems AHU-1, AHU-2, and the RTUs upon fire alarm.

.9 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_2 levels are above 800 ppm (1 hour delay)

.10 Points List

Name	**AI**	**AO**	**DI**	**DO**
Space Temperature	X			
Space Temperature Adjustment	**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
Mixed/OA damper Command		**X**		
Occupied/Unoccupied Command				**X**
Mix Air Temperature	**X**			
Supply Air Temperature	X			
Return Air CO_2	X			
Return Air Temperature	X			
Freeze Stat Status			**X**	
Unit Alarm			**X**	

.4 **PACKAGED HVAC (VAV DX, GAS, DISCHARGE AIR RESET)**

.1 General

.1 The variable volume air handling units consists of a mixed air section with outdoor air, exhaust air and return air dampers, filter, gas fired burner, packaged cooling, supply and return fans with variable frequency drives. The unit is DDC controlled using electric actuation. **For HVAC 5, a remote ERV is integrated into the sequences.**

.2 Sequences are to meet ASHRAE Standard 36, High Performance Sequences of Operation for HVAC Systems. The BAS Contractor is responsible for full integration of the sequences, along with any additional requirements listed below.

.3 Time delays shall be provided to prevent unit short cycling.

.4 Fan status shall be reported.

.5 Units shall have a staggered start delay programmed into them for start-up on power failure.

.2 Safeties and Limits

.1 Freeze Protection: Provide programming to ASHRAE Guideline 36 standard. There are three levels of freeze protection to be programmed into the software:

.1 If supply air temperature drops below 4.4°C (40°F) for 5 minutes, enable heating plant, override outdoor air damper position/ERV operation to minimum, and modulate the heat to maintain a supply air temperature of at least 6°C (42°F). Disable this function once the supply air temperature rises above 7°C (45°F) for 5 minutes.

.2 If supply air temperature drops below 3.3°C (38°F) for 5 minutes, fully close both the economizer/outdoor air damper for 1 hour and set an alarm at the OWS. After 1 hour the unit shall resume minimum outdor air ventilation and entre the previous stage of freeze protection.

.3 If supply air temperature drops below 3.3°C (38°F) for 15 minutes or below 1°C (34°F) for 5 minutes, shut down supply and return fans, close outdoor air damper, open both the chilled water valves and energize both pumping systems. Also ensure heating plant is enabled, and modulate the heating valve to maintain the higher of the supply air temperature or mixed air temperature at 27°C (80°F), and send an alarm to the OWS. The freeze protection shall remain in place until reset by a software switch at the OWS.

.4 Provide a hardwired freeze stat that must be manually reset as a final safety.

.3 System Start/Stop

.1 The unit fan may run in any mode except for unoccupied mode.

.2 The unit shall only run in setback mode if there is a perimeter zone without perimeter radiation, or after the perimeter radiation has failed to maintain set point for a minimum of 15 minutes.

.3 Provide an override switch at the OWS to enable the unit for 3 hours.

.4 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.

.4 Control Strategy

.1 Provide a summation of total airflow from the VAV boxes on the graphic for the unit.

.2 Determination of AHU Mode of Operation

.1 AHU system modes are the same as the zone groups served by the system. When zone groups served by an air-handling system are in different modes, the following hierarchy applies:

.1 Occupied mode

.2 Cool down mode

.3 Setup mode

.4 Warm-up mode

.5 Setback mode

.6 Freeze Protection setback mode

.7 Unoccupied mode

.5 Static Pressure Control

.1 Static Pressure Reset. Provide static pressure reset using Trim and Respond Set-Point Logic to ASHRAE Standard 36, High-Performance Sequences of Operation. All parameters shall be adjustable by the operator at the OWS.

.2 BAS shall modulate the VFD of the supply and return fans to maintain the static pressure set point.

.3 The speed AO sent to the VFDs shall be configured such that 0% speed corresponds to 0 Hz, and 100% speed corresponds to maximum speed configured at the VFD. This does not necessarily correspond to 60 Hz.

.6 Supply Air Temperature Control

.1 The Supply Air temperature control loop is enabled at all times that the supply air fan is proven on and disabled and output set to deadband (no heating, outdoor air damper closed) otherwise.

.2 Supply Air Temperature Set Point. Supply Air Temperature is to be reset and controlled to ASHRAE Guideline 36, using Trim and Respond logic. Design variables are as follows:

.1 Minimum Cooling Supply Air Temperature: 12°C (55°F)

.2 Maximum Cooling Supply Air Temperature: 18°C (65°F)

.3 OAT Minimum: 16°C (60°F)

.4 OAT Maximum: 21°C (70°F)

.3 Supply air temperature in heating mode shall be kept as low as possible so that heat can be delivered by the VAV reheat coils.

.4 All Trim and Respond variables and set points shall be adjustable from the OWS.

.5 During occupied mode and setup mode, the SAT set point shall be reset from Minimum Cooling Supply Air Temperature when the OAT is at OAT maximum and above, proportionally up to a maximum temperature, T-max when the outdoor air temperature is at OAT minimum and below.

.6 T-max shall be reset using Trim and Respond Logic between the minimum cooling supply air temperature and the maximum cooling supply air temperature.

.7 See controls diagram from ASHRAE Guideline 36 below:

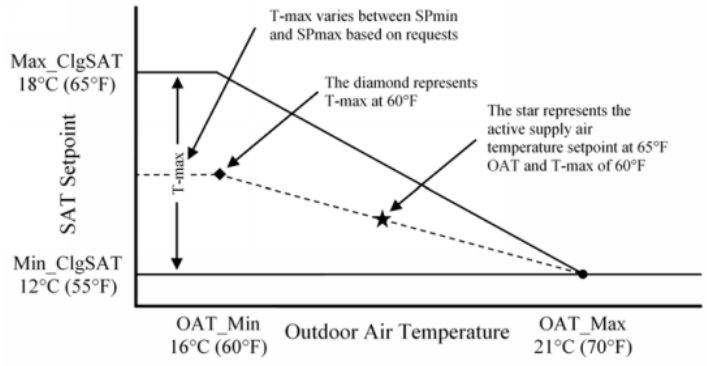


Figure 5.16.2.2 Example supply air temperature reset diagram.

.8 During the cooldown mode, the set point shall be the minimum cooling supply air temperature.

.9 During the warm-up and setback modes the set point shall be:

.1 35°C (95°F) for systems with zones without reheat.

.2 21°C (70°F) for systems with VAV reheat or perimeter heat in all zones.

.10 Provide logic to allow the VAV unit to act as the primary heat source and increase supply air temperature to 32°C (90°F) in case of central plant failure of branch piping shut down.

.11 The supply air temperature shall be controlled to set point shall be sent to the AHU.

.7 Minimum Outdoor Airflow Control

.1 ASHRAE Guideline 36 logic shall be modified to allow for CO_2 demand control ventilation based on a CO_2 reading in the return air duct.

.2 The ERV shall be enabled during all occupied hours and represents the minimum ventilation rate. When in minimum ventilation rate, the AHUs OA damper shall be fully closed.

.3 The ERV shall be set to free cooling mode when conditions are appropriate.

.4 Provide a minimum outdoor air control loop which is enabled whenever the AHU is in operation and in occupied mode. Set output to zero otherwise. Provide an IAQ signal to the unit for internal operation of the dampers, return fan etc.

.5 During occupied times:

.1 The outdoor air damper will remain closed until a preset value of 1000 ppm is reached. Beyond that value the damper shall modulate open until a minimum value of 800 ppm is reached.

.2 Reset the CO_2 setpoint up by 200 ppm with the mechanical cooling is in operation.

.6 The demand for economizer operation shall override the outdoor air damper position and exhaust/return fan control.

.7 Control loop mapping shall be as follows:

.8 Air Side Economizer

.9 The unit shall control the air side economizer operation.

.8 Return Fan and Building Pressure control

.1 Return fan shall operate whenever the associated supply fan is proven on, and shall be off otherwise.

.2 Return fan shall be controlled to maintain return fan discharge static pressure at set point.

.3 Exhaust dampers shall only be enabled when the associated supply and return fans are proven to be on, and the minimum outdoor air damper is open. The exhaust dampers shall be closed otherwise.

.4 The building static pressure shall be time averaged with a sliding 5-minute window to dampen fluctuations. The averaged value shall be that displayed and used for control.

.5 When exhaust dampers are enabled, a control loop shall modulate exhaust dampers in sequence with the return fan static pressure set point as indicated below to maintain the building pressure at a set point of 12 Pa (0.05 in. of water):

.1 From 0% to 50%, the building pressure control loop shall modulate the exhaust dampers from 0% to 100% open.

.2 From 51% to 100%, the building pressure control loop shall reset the return-fan discharge static pressure set point from its minimum to maximum. Static set points to be provided by the balancer.

.9 Alarms

.1 Maintenance interval alarm once fan has operated for 1500 hrs.

.2 Supply fan status/command mismatch (1 minute delay)

.3 Return fan status/command mismatch (1 minute delay)

.4 Freeze stat alarms as listed under Limits and Safeties section.

.5 Supply air temperature above 35°C (5 minute delay)

.6 Return air temperature is more than 5 degrees from space set point (5 minute delay)

.7 Unit is running and return air CO_2 levels are above 800 ppm (1 hour delay)

.8 Heat wheel or other alarm is received from unit controller (immediate)

.9 Unit not cooling when commanded, as indicated by SAT (5 minute delay)

.10 Unit not heating when commanded, as indicated by SAT (5 minute delay)

.11 High Building Pressure (more than 25 Pa (0.10 in. of water)

.12 Low Building Pressure (less than 0 Pa (0.0 in of water)

.10 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
Supply Fan Command				X
Supply Fan Speed Modulation		X		
Supply Fan Status	X			
Supply Fan Alarm			X	
Supply Duct Static Pressure	X			
Return Fan Command				X
Return Fan Speed Modulation		X		
Return Fan Status	X			
Return Fan Alarm			X	
Discharge Air Setpoint		X		
Heating Lockout				X
Gas Burner Status	X			
Cooling Lockout				
DX Cooling Status	X			
Supply Air Flow Volume	X			
Supply Air Temperature	X			
Supply Air Humidity	X			
Return Air Temperature	X			
Return Air CO_2	X			
Return Air Humidity	**X**			
Mixed Air Temperature	X			
Freeze Stat Status			X	
Unit Alarm			X	

.5 **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			

.6 **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			

.7 **EXHAUST FANS (HEAT REJECTION)**

.1 Start/stop exhaust fans based on space temperature.

.2 Space temperature shall be indicated on the BAS. Use of local reverse acting thermostats is not acceptable.

.3 Exhaust fan shall operate with motorized dampers on the exhaust ductwork, and on the make up air ductwork if motorized dampers are indicated on the plans. Confirm dampers are open prior to sending fan command.

.4 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.

.5 Points List

Name	AI	AO	DI	DO
Exhaust Fan Command				X
Exhaust Fan Status	X			
Space Temperature	X			
Motorized Damper Command				X
Motorized Damper Feedback			X	

.8 **BYPASS BOX CONTROL**

.1 DDC Control shall modulate damper to maintain space temperature set point as follows:

.1 Occupied Mode: Damper shall modulate to maintain a space temperature. Damper shall modulate in conjunction with local radiant heat where applicable.

.2 Unoccupied Mode: Bypass box shall provide airflow to the space and send a heat/cool call to the packaged HVAC unit as required. Unit shall enter occupied mode until the room setpoint is satisfied.

.3 Upon signal from the associated HVAC unit's leak detection system:

.4 Disable any electric reheat or other sources of ignition in the ductwork system.

.5 Fully open zone dampers within the ductwork system/close bypasses.

.6 Energize all fans within the duct system/general exhaust fans in area affected.

.7 Points List

Name	AI	AO	DI	DO
Damper Command		X		
Space Temperature	X			

.9 **FAN COIL**

.1 The fan runs continuous through occupied periods. Provide a CSR on the fan.

.2 Provide a space sensor and controller/operator.

.3 The space sensor modulates the heating and cooling 2-way valves to maintain space temperatures.

.4 During unoccupied mode on a call for heating the fan cycles in conjunction with the 2-way heating & cooling valves to maintain space temperatures.

.5 Safeties and Limits

.1 The discharge air temperature shall be controlled to be no greater than 30 degrees F above the space set point.

.2 System Start/Stop. Not applicable. Refer to multizone AHU sequences of operation.

.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.

.6 Alarms

.1 Low Airflow

.1 Measured airflow is less than 70% of set point for 5 minutes (while set point is greater than 0).

.2 Measured airflow is less than 50% of set point for 5 minutes (while set point is greater than 0).

.3 If a zone has an importance-multiplier of 0 for its static pressure reset control loop, low airflow alarms shall be suppressed.

.2 Low-Discharge Air Temperature

.1 If heating plant is on, and DAT is 8°C (15°F) less than set point for 10 minutes.

.2 If heating plant is on, and DAT is 17°C (30°F) less than set point for 10 minutes.

.3 If a zone has an importance multiplier of 0 for it's hot water reset control loop, low discharge air temperature alarms shall be suppressed.

.3 Airflow Sensor Calibration: If the fan serving the zone has been off for 10 minutes and the airflow sensor reading is above 10% of the cooling maximum airflow set point.

.4 Leaking Valve: If the valve position is 0% for 15 minutes, DAT is above AHU SAT by 3°C (5°F) and the fan serving the zone is on.

.5 Fan Command/Status mismatch after 1 minute.

.7 Points List

Name	**AI**	**AO**	**DI**	**DO**
Space Temperature	X			
Temperature Control Valve Modulation		**X**		
Temperature Control Valve Modulation		**X**		
Fan Command				X
Fan Status	X			

.10 **FORCE FLOW HEATERS (UNIT HEATERS SIMILAR)**

.1 A temperature sensor energizes the fan to maintain setpoint. Fan status is monitored and alarms to BAS when it does not match command.

.2 **Temperature sensor shall also modulate associated Temperature Control Valve**

.3 The control system shall maintain the following temperatures:

.4 Occupied mode 18°C for vestibules/stairwells.

.5 Unoccupied mode: 13°C.

.6 Provide alarm if space temperature is below 10°C.

.7 Points List

Name	**AI**	**AO**	**DI**	**DO**
Space Temperature	X			
Fan Command				X
Fan Status	X			

.11 **CONVECTORS (RADIANT PANELS AND WALLFIN SIMILAR)**

.1 Space Temperature Control

.1 Occupied Mode

.2 Radiation valves shall be modulated to maintain space temperature.

.3 Unoccupied Mode

.4 The heat setpoint shall be lowered to maintain space temperature.

.5 Points List

Name	AI	AO	DI	DO
Space Temperature	X			
Space Temperature Adjustment	**X**			
Temperature Control Valve Modulation		**X**		
Temperature Control Valve Command				**X**

.12 **ELECTRIC FORCE FLOW HEATER CONTROL**

.1 Space Temperature Control

.1 Occupied Mode

.2 A temperature sensor energizes the unit to maintain setpoint (connect to relay provided by Electrical Division.

.3 Unoccupied Mode

.4 The heat setpoint shall be lowered to maintain space temperature.

.5 Points List

Name	AI	AO	DI	DO
Space Temperature	X			
Space Temperature Adjustment	**X**			
Relay Command				**X**

.13 **MECH ROOM TEMPERATURE CONTROL**

.1 Room Temperature Control.

.1 The room temperature control consists of a temperature sensor, a forced flow unit heater fan motor, modulating control valve, and an exhaust air fan and a supply air fan.

.2 The DDC will control using electric actuation.

.3 The controller monitors the room temperature sensor.

.4 On a call for cooling the unit heater control valve is closed and the fan motor is off, controller will start exhaust and supply fan motor to maintain room temperature setpoint.

.5 On a call for heating the exhaust fan motor is off, controller will modulate unit heater control valve and the unit heater fan motor is on to maintain room temperature setpoint.

.6 The DDC system uses current switches 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.

.2 Points List

Name	AI	AO	DI	DO
Space Temperature	X			
Exhaust Fan Command				X
Exhaust Fan Status	X			
Supply Fan Command				X
Supply Fan Status	X			
Unit Heater Fan Command				X
Unit Heater Fan Status	X			
Heating Valve Modulation		X		

.14 **IT ROOM TEMPERATURE CONTROL (Elec and Lan room Similar)**

.1 General

.1 The BAS shall control the IT room cooling system.

.2 Limits and Safeties

.1 The discharge air temperature from the indoor fan coil unit shall be maintained above 10°C.

.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 Control Strategy

.1 The BAS shall provide a temperature and humidity set-point to the unit to maintain.

.2 Unit controls shall control unit operation to maintain set point. BAS contractor shall be responsible for commissioning and set up of equipment.

.3 Provide space temperature and humidity sensor that is separate from unit sensors.

.4 Provide graphic indicating status of all heating, cooling, fans, reheat and discharge air temperature and humidity.

.4 Alarms

.1 Monitor all unit alarms.

.2 Alarm if space temperature rises 3°C above set point.

.5 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
Space Temperature Set Point		X		
Space Humidity Set Point		X		
Unit Alarm			X	
Space Temperature	X			
Unit Fan Status	X			
Unit Heat/Cool/Reheat Status			X	
Unit Discharge Air Temperature	X			
Unit Discharge Air Humidity	X			
Exhaust Fan Command				
Exhaust Fan Status	X			

.15 **DOMESTIC WATER SYSTEM CONTROL**

.1 Provide supply temperature indication with strap on sensor on domestic hot water pipe for two (2) domestic hot water systems.

.2 The recirculation pumps will be started/stopped on a time of day schedule.

.3 Recirculation pump status shall be monitored.

.4 Alarms shall be provided for the following:

.1 Recirc pump start/stop/status mismatch (5 minute delay).

.2 Domestic hot water supply temperature rises above 62 degrees C for kitchen loop.

.3 Domestic hot water supply temperature rises above 45 degrees C for main building loop.

.5 Points List

Name	AI	AO	DI	DO
Supply Water Temperature	X			
Recirc Pump Command				X
Recirc Pump Status	X			

.16 **TRAP PRIMER STATIONS**

.1 Once per day the BAS shall operate the trap primer solenoid valves to provide a water to the trap primer header.

.2 The injection shall be 6 seconds (adjustable by operator)

.3 Alarm shall be provided to the operator if end switch is not confirmed.

.4 Points List

Name	AI	AO	DI	DO
Valve command				X
Valve Endswitch			X	

.17 **PHASE LOSS DETECTION**

.1 Provide current sensing relays on the BUSS in the MCC at the dedicated section.

.2 Turn off all connected equipment.

.3 Sequence equipment on when power is restored.

.4 Provide alarm at OWS on loss of power.

.18 **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**	

.19 **CHILLER LOOP CONTROL (CH-1)**

.1 All The chilled water system shall be enabled to run whenever the chilled water system manual enable point is enabled (or dehumidification is enabled), the chilled system calendar enable point is enabled, and the outdoor air temperature is above the OA-T enable setpoint (adjustable, initially set at 18 deg C). The system shall be disabled when the outdoor air temperature is lower than the OA-T enable setpoint, plus a differential of 2 deg C, or if the manual enable point or calendar enable point have been disabled. The system will also look at any temporary calendars and schedules (adjustable) to determine if the system should be enabled or not. When the system has been disabled, all pumps which are running at that time will continue to run for 10 minutes before turning off.

.2 To prevent short cycling, the chiller shall run for and be off for minimum adjustable times (10 minutes, adjustable), unless shutdown on safeties or outside air conditions. On a call for cooling, the chiller and chilled water circulating pumps shall be enabled. Once the circulating pumps status has been received by the BAS, that chiller's demand signal will be modulated to satisfy the calculated primary chilled water supply temperature.

.3 The demand signal for any chiller will be throttled back if the chiller's individual chilled water supply temperature drops below its supply temperature high limit setpoint (adjustable, initially set at 6 deg C). If the chiller's general alarm point is in alarm, that chiller will be disabled.

.4 After the chiller has shutdown, its associated circulating pumps shall remain on for a short amount of time (10 minutes, adjustable).

.5 Enable chiller and chilled water loop operation at outdoor air temperatures above 18 degrees C. (adj.). Chiller and associated pumps enable requires proof of either system pump status 'ON'

.6 When the chilled water system is enabled, the glycol loop pumps (C-7, C-8) will be enabled via chiller internal controls. System loop pumps C-5 and C-6 will be enabled via BAS. When the pump status is received by the BAS, the primary loop control scheme will be enabled. The glycol loop pumps (C-7, C-8) shall run in series on a lead/standby basis. The System Circulation pumps (C-5, C-6) shall run in series on a lead/standby basis. A run time counter will determine lead pumps. When there is no chilled water demand signal the pumps, shall be OFF. When there is no chilled demand signal the pumps shall be off and shall be enabled for 2 hours Pump Cycle per week. Pumps shall have a minimum off time of 5 minutes. Failure of either lead/lag pump starts standby pump.

.7 Wire loose devices and connect to chiller control panel provided by the chiller manufacturer in accordance with the manufacturer's instructions.

.8 Chiller enables requires proof of water flow (5 min delay start-up).

.9 Control wiring between pumps C-5, C-6, C-7 & C-8 and chiller shall be by this contractor

.10 A sensor in the chilled water supply shall sequence the chiller compressors, to maintain the supply water temperature set point. Chilled water temperature setpoint is reset a maximum 5°C off return water temperature.

.11 Monitor the alarm points from the chiller.

.12 Monitor chiller loop flow from a flow switch.

.13 Provide indication of the chilled water supply and return water temperatures and the OAT, at the OWS.

.14 Provide an alarm at the OWS should the pumps fail or supply or return water temperatures exceed the programmable alarm limits.

.15 Pressure Control (C-5 and C-6)

.1 The BAS shall control the pump VFD set point to maintain the system pressure set point.

.2 Pressure set point reset shall be provided to maximize energy savings. Reset shall use a PID loop based on valve commands in the system.

.3 If the system differential is below set point and pump on high speed for more than 15 minutes, the lag pump starts. If both pumps are on and the system differential pressure is at set point and the pumps are on high speed for more than 15 minutes the lag pump is stopped.

.4 BAS shall modulate bypass valve as required to maintain minimum flow.

.16 Points List

Name	AI	AO	DI	DO
Chiller Command				X
Chiller Status			X	
Chiller Alarm			X	
Chiller Modulation		**X**		
Chiller Circulator Command				**X**
Chiller Circulator Status	X			
System Pump(s) Command				X
System Pump(s) Status	X			
System Pump(s) Alarm			X	
Loop Supply Temperature	X			
Loop Return Temperature	X			
System Pump(s) Speed Modulation		**X**		
Differential Pressure Set Point		**X**		
Differential Pressure Reading	**X**			
Chilled Water Supply Temperature (multiple)	X			
Chilled Water Return Temperature (multiple)	X			
Chiller Discharge Temperature	**X**			
Glycol Chilled Supply Temperature	X			
Glycol Chilled Return Temperature	X			
Chilled Water Supply Temperature Set Point		**X**		
Defrost Status			X	

.20 **BOILER PLANTS (CONDENSING PRIMARY SECONDARY)**

.1 General

.1 The boiler system provides primary hot water for the building.

.2 Boilers are equipped with factory supplied and installed controllers and safeties. **The BAS will stage the boilers to maintain temperature.**

.3 The lead boiler will be rotated weekly to equalize runtimes. The lead boiler designation shall alternate weekly. If the lead boiler should fail, the lag boiler will be started.

.4 The two system pumps will be rotated weekly to equalize runtimes. The lead pump designation shall alternate weekly. If the lead pump should fail, the lag pump will be started after a 15 second delay.

.5 The boiler circulation pumps shall be controlled by the boiler**.** Pump status shall be monitored.

.6 The boilers shall be integrated via terminal strip.

.2 Safeties and Limits

.1 Minimum start and stop time delays are provided on all outputs to prevent short cycling of equipment.

.2 Boilers have a minimum on time of 5 minutes and off time of 2.5 minutes.

.3 If the outdoor air sensor fails, the boiler system will be enabled. The setpoints will set to -5° C outside air temperature.

.4 The system pumps will run for 10 minutes after the boilers shut down to dissipate heat.

.5 The boiler circulation pumps shall run for 10 minutes after the boilers shut down to dissipate heat.

.6 Control each boilers discharge temperature to ensure it does not cross the high limit of 93.3 degrees C (i.e. limit boiler modulation as discharge temperature approaches high limit).

.3 System Start/Stop

.1 The system will be enabled whenever any of the following occurs:

.1 The outside air temperature is less than 5° C.

.2 The outside air temperature is less than 15° C and the building is occupied.

.2 The system will be disabled whenever any of the following occur:

.1 There are no heat-requests from the building and the outside air temperature rises above 18° C for more than 30 minutes.

.2 There are no heat requests from the building and the outside air temperature rises above 5° C for more than 1 hour and the building is unoccupied.

.3 When the system is enabled the lead boiler primary pump shall operate continuously.

.4 Control Strategy

.1 Heating will be enabled once pump status is confirmed.

.2 HWS temperature shall be reset based on a three point curve of outdoor air according to following schedule:

Primary Loop Temperature	Outdoor Air Temperature
66°C	-15°C
55°C	-5°C
42°C	21°C

.3 The outdoor air reset schedule will shift up or down to satisfy the heating requests from the system and the set point will be adjusted between a minimum of 32 and a maximum of 66 degrees C.

.4 If heating PID output is greater than 80%, lag boiler circulator pump shall start. Once pump status is confirmed both boilers shall modulate in unison to maintain set point.

.5 If heating PID output drops below 40%, lag boiler is disabled. Lag pump shall disable after 10 minute time delay to dissipate excess heat.

.6 Boilers shall be staged to bring on second boiler once first boiler reaches 50% firing (i.e. both boilers shall fire at 25% then modulate up together). The next boiler shall be brought on once both running boilers are at 50%, then all three boilers shall modulate together. This approach shall continue until all boilers in the system are firing.

.5 Pressure Control

.1 The BAS shall control the pump VFD set point to maintain the system pressure set point.

.2 Pressure set point reset shall be provided to maximize energy savings. Reset shall use a PID loop based on valve commands in the system.

.3 If the system differential is below set point and pump on high speed for more than 15 minutes, the lag pump starts. If both pumps are on and the system differential pressure is at set point and the pumps are on high speed for more than 15 minutes the lag pump is stopped.

.4 BAS shall modulate bypass valve as required to maintain minimum flow.

.6 An alarm for the following shall be generated on the BAS:

.1 Boiler status is received and its primary pump status is off or the boiler is commanded off.

.2 Boiler status is not received and the boiler command is on (5 minute delay).

.3 Boiler alarm contact indicates boiler is in alarm.

.4 Pump status is received and the command is off (10 minute delay).

.5 Pump status is not received and the command is on, or status and command mismatch (5 minute delay).

.6 The heating system is on and the primary supply water temperature is more than 10 degrees from setpoint (10 minute delay).

.7 An alarm will be generated with the outdoor temperature is below 4° C and the boiler return water temperature is below 32° C.

.8 An alarm will be generated if any space temperature is below 10° C.

.9 The boiler makeup water meter will be monitored through the BAS, and the consumption will be totalized. An alarm will be generated by the BAS if an abnormally large consumption of water is occurring.

.10 An alarm will be generated if the boiler loop pressure sensor drops below an adjustable threshold.

.11 System differential pressure deviates from set point.

.7 Points List

Name	AI	AO	DI	DO
Boiler Command				X
Boiler Status			X	
Boiler Alarm			X	
Bypass Valve Command		**X**		
Boiler Modulation		**X**		
Boiler Circulator Command				**X**
Boiler Circulator Status	X			
System Pump(s) Command				X
System Pump(s) Status	X			
System Pump(s) Alarm			X	
System Pump(s) Speed Modulation		**X**		
Differential Pressure Set Point		**X**		
Differential Pressure Reading	**X**			
Hot Water Supply Temperature	X			
Hot Water Return Temperature	X			
Boiler Discharge Temperature	**X**			
Hot Water Supply Temperature Set Point		**X**		

.21 **GLYCOL HOT WATER HEATING LOOP HEATING CONTROL (HEAT EXCHANGER)**

.1 Start the hot water heating pumps C-3 and C-4 at outdoor air temperatures less than 10°C. (adj.).

.2 Alternate circulating pump motors for wear. Pump status shall be provided via CSR. Failure of either lead/lag pump starts standby pump.

.3 Provide a sensor in the hot water supply and return. On a call for heating open the 3-way valve to maintain loop temperature.

.4 Monitor pump status/flow.

.5 Monitor glycol tank level.

.6 Provide an alarm at the OWS should the pump fail or supply or return water temperatures exceed the programmable alarm limits.

.7 A pump status alarm occurs either if the system is enabled or the hot water supply pumps status are not obtained after one minute.

.8 Points List

System Pump(s) Command				X
System Pump(s) Status	X			
System Pump(s) Alarm			X	
Glycol Hot Water Supply Temperature	X			
Glycol Hot Water Return Temperature	X			
Hot Water Supply Temperature	X			
Hot Water Return Temperature	X			
Valve Command		**X**		
Valve Modulation		**X**		

.22 **ELECTRICAL/GAS/WATER METER INTEGRATION**

.1 Integrate electrical meters provided as part of switchboard into BAS to provide monitoring of instantaneous electrical load, as well as a variety of totalization and trending.

.2 Provide meters to monitor gas and domestic water usage as indicated on drawings.

.3 Coordinate all utility monitoring requirements with Karma monitoring system contractor.

.4 Co-ordinate exact method of integration with electrical trade.

.5 Points List

Name	**AI**	**AO**	**DI**	**DO**
Electrical Use	X			
Gas Use	X			
Water Use	X			

.23 **BUILDING LOW TEMPERATURE**

.1 All space sensors shall be capable of indicating building low temperature. Alarm building low temperatures at OWS.

.24 **FIRE ALARM INTEGRATION**

.1 The fire panel monitoring consists of one dry contact at fire alarm panel as supplied by panel manufacture.

.2 The DDC will monitor fire panel contact and generate an alarm if contact closes.

.3 The BAS/DDC system will enter fire alarm system mode as approved by local fire authority and mechanical engineer.

.4 Points List

Name	**AI**	**AO**	**DI**	**DO**
System Status			X	

.25 **SECURITY SYSTEM INTEGRATION**

.1 Monitor the armed/un-armed operation of the security system. Provide alarm indication at the OWS.

.2 Use security setting to program exterior lighting on in the event of an armed signal, program to go off when system is disarmed.

.3 Include readings in the graphics package.

.4 Points List

Name	AI	AO	DI	DO
System Status			X	

.26 **RECEPTACLE INTEGRATION**

.1 The BAS shall enable/disable the receptacles identified on the electrical drawings based on a time of day schedule to meet the prescriptive requirements of ASHRAE 90.1 This contractor shall review the electrical drawings for locations and number of contacts.

.2 Points List

Name	AI	AO	DI	DO
Power Interruption				X

.27 **DOMESTIC WATER FLUSHING VALVE**

.1 Energize zone solenoid valves for five minutes (adj) each 24 hour period (adj) during unoccupied times.

.2 Sequence zone valves so that no more than two (2) valves operate at the same time.

.28 **SINGLE DUCT VAV BOXES WITH REHEAT**

.1 General

.1 Controls logic to be provided to meet ASHRAE Guideline 36, High-Performance Sequences of Operation for HVAC Systems. A summary of this standard follows, but BAS contractor remains responsible for the full implementation of the standard along with any additional notes indicated below.

.2 Design flow rates are indicated on the VAV Schedule on the drawings. Controls contractor shall calculate all required airflow settings as indicated elsewhere in this section. All settings shall be independently adjustable by the operator.

.3 Supply air temperature shall be monitored and displayed at the OWS.

.4 Supply air volume shall be monitored and displayed at the OWS.

.5 Space temperature sensors are equipped with a warm/cool adjust and occupancy override button. Warm/cool adjust shall be set point by 2 degrees C. Override button will extend occupancy hours by two hours.

.6 Safeties and Limits

.1 The discharge air temperature shall be controlled to be no greater than 30 degrees F above the space set point.

.2 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.

.2 System Start/Stop. Not applicable. Refer to multizone AHU sequences of operation.

.3 Control Strategy

.1 Active maximum and minimum air flow set points shall vary depending on the mode of the zone group the VAV is a part of.

Set Point	Occupied	Cool down	Warm-Up	Unoccupied
Cooling Maximum	Vcool-max	Vcool-max	0	0
Cooling Minimum	Vcool-min	0	0	0
Minimum	Vmin	0	0	0
Heating Minimum	Larger of Vheat-min or Vmin	Heating Minimum	Heating Maximum	0
Heating Maximum	Larger of Vheat-max or Vmin	Heating Maximum	Cooling Maximum	0

.2 Maximum and minimum airflows shall be set as follows:

.1 Vcool-max: Design airflow, plus 30%.

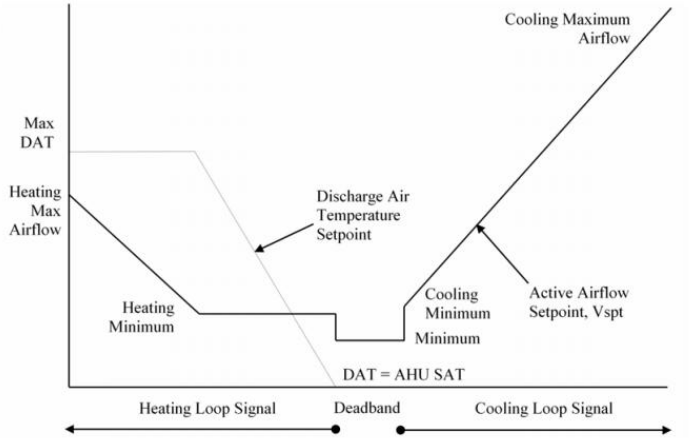
.2 Vcool-min: 30% of design airflow.

.3 Vheat-max: 80% of design airflow.

.4 Vheat-min: 0 cfm.

.5 Vmin: 30% of design airflow.

.3 Control logic is depicted schematically in the figure below and described in the following sections.



.4 Cooling Zone State: The cooling loop output shall be mapped to the airflow set point from the cooling minimum to the cooling maximum set points. Heating coil is disabled unless discharge air temperature is below the minimum set point. Note that if the supply air temperature from the air handler is greater than room temperature, cooling supply airflow set point shall be no higher than the minimum.

.5 Deadband Zone State: The active airflow set point shall be the minimum airflow set point. Heating coil is disabled unless the discharge air temperature is below the minimum set point.

.6 Heating Zone State: The heating loop shall maintain space temperature at the heating set point as follows:

.1 From 0 to 50%, the heating loop output shall reset the discharge air temperature set point from the current AHU SAT set point to the maximum above space temperature set point (30°F). The airflow setpoint shall be the heating minimum.

.2 From 51% to 100%, if the DAT is greater than the room temperature plus 3°C (5°F), the heating loop output shall reset the airflow set point from the heating minimum airflow set point to the heating maximum airflow set point.

.3 The heating coil shall be modulated to maintain the discharge air temperature set point.

.4 System Requests

.1 Cooling SAT reset requests

.1 If the zone temperature exceeds the zone's cooling set point by 3°C (5°F) for 2 minutes, send 3 requests.

.2 Else if zone temperature exceeds the zone's cooling set point by 2°C (3°F) for 2 minutes, send 2 requests.

.3 Else if the cooling loop is greater than 95%, send 1 request until the loop is less than 85%.

.4 Else if the cooling loop is less than 95%, send 0 requests.

.5 Repress requests for 5 minutes after a reset to the SAT.

.2 Static Pressure reset requests

.1 If the measured airflow is less than 50% of set point while set point is greater than zero and the damper position is greater than 95% for 1 minute, send 3 requests.

.2 Else if the measured airflow is less than 70% of set point while set point is greater than zero and the damper position is greater than 95% for 1 minute, send 2 requests.

.3 Else if the damper position is greater than 95%, send 1 request until the damper position is less than 85%.

.4 Else if the damper is less than 95%, send 0 requests.

.5 Repress requests for 5 minutes after a reset to the static pressure.

.3 Hot Water reset requests

.1 If the DAT is 17°C (30°F) less than set point for 5 minutes, send 3 requests.

.2 If the DAT is 8°C (15°F) less than set point for 5 minutes, send 2 requests.

.3 Else if HW valve position is greater than 95%, send 1 request until the HQ valve position is less than 85%.

.4 Else if the HW valve position is less than 95%, send 0 requests.

.5 Repress requests for 5 minute after a reset to the hot water temperature.

.5 Alarms

.1 Low Airflow

.1 Measured airflow is less than 70% of set point for 5 minutes (while set point is greater than 0).

.2 Measured airflow is less than 50% of set point for 5 minutes (while set point is greater than 0).

.3 If a zone has an importance-multiplier of 0 for it's static pressure reset control loop, low airflow alarms shall be suppressed.

.2 Low-Discharge Air Temperature

.1 If heating plant is on, and DAT is 8°C (15°F) less than set point for 10 minutes.

.2 If heating plant is on, and DAT is 17°C (30°F) less than set point for 10 minutes.

.3 If a zone has an importance multiplier of 0 for it's hot water reset control loop, low discharge air temperature alarms shall be suppressed.

.3 Airflow Sensor Calibration: If the fan serving the zone has been off for 10 minutes and the airflow sensor reading is above 10% of the cooling maximum airflow set point.

.4 Leaking Damper: If the damper position is 0% and airflow sensor is above 10% of the cooling maximum airflow set point for 10 minutes while the fan serving the zone is on.

.5 Leaking Valve: If the valve position is 0% for 15 minutes, DAT is above AHU SAT by 3°C (5°F) and the fan serving the zone is on.

.6 Points List

Name	**AI**	**AO**	**DI**	**DO**
Damper Command		X		
Airflow Volume	X			
Discharge Air Temperature	X			
Temperature Control Valve Modulation		X		
Space Temperature	X			
Space Temperature Adjustment	**X**			

.29 **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			

3.10 ELECTRICAL

.1 Rules and Regulations: The entire installation shall conform to Division 26 and shall comply with the Canadian Electrical Code and all local and Provincial codes. The contractor shall obtain an ESA certificate for his work.

.2 Refer to equipment wiring schedule on the electrical drawings for wiring responsibilities.

.3 Arrange for all the necessary inspections and approvals of built-up and modified control systems and relay panels by governing authorities. All electrical equipment, material, and its installation shall conform to the current requirements of the following authorities:

.1 C.S.A

.2 Ontario Hydro Safety Authority

.3 O.B.C. Building Codes / Fire Codes.

.4 All wiring shall conform to governing codes and shall be inspected by request of the contractor for approval. The contractor shall obtain and purchase all necessary permits as required.

.5 Wiring: All electric wiring in connection with this project shall be furnished and installed under this section.

.1 The Contractor shall be aware that cables carrying high currents run through ceiling and wall cavities. Signal interference or sensor inaccuracy or failure caused by existing cable runs shall be the responsibility of the Contractor and shall be covered under the warranty. The Contractor shall select sensors and use shielded cable or transmitters as necessary to prevent electrical interference with the control system operation.

.2 The Contractor shall coordinate fully the interconnection of factory assembled portions of system controls, field installed control systems and the electrical power system to provide a complete working installation.

.3 Power for control equipment shall not be taken from equipment motor leads. Power shall be from circuits dedicated for controls only.

.4 Transformers shall be sized for 150% of engineered capacity.

.5 All wires are to be numbered using wire labels at each end. These labels shall correspond to wire identification on the shop drawings and "as-built" drawings.

.6 All wiring concealed in walls and chases and all exposed wiring shall be run in conduit.

.6 Electrical Isolation of I/O Points: To prevent serious damage to the field panels from surges, or RFI electrically induced spikes, protection in the following form shall be provided, as a minimum:

.1 Digital outputs singularly or collectively shall be galvanically isolated from the main panel processor.

.2 Analog outputs shall be galvanically isolated from each other and the main panel processor.

.3 Digital inputs shall be galvanically isolated from the main panel processor.

.7 Panel Documentation: Mount an input/output layout sheet within each controller field panel. This sheet shall include the name of the points connected to each controller channel.

.8 Conduits: All wiring in finished areas shall be concealed. All exposed wiring, whether for power, sensors, actuators, or data communications, shall be in metallic conduit. This includes all wiring runs in and around rooftop HVAC units. All conduits shall have a minimum inside diameter of 13mm.

.1 All conduits shall be installed out of the way in traffic areas, and parallel to the lines of the building. Flexible conduit may be used only in areas of vibration or expansion joints. All conduits shall be supported at least every 4 feet.

Supports shall be located at each connector end of each conduit. High and low voltage wire shall not be run in the same conduit.

Only wires of similar purpose shall be run in the same conduit; i.e. sensor or control, power, and communication wire shall be in separate conduit.

.9 Pull Boxes and Junction Boxes: Pull boxes shall be located at a minimum spacing of 30m. The contractor is responsible for getting approvals from the Owner for locating pull boxes. Pull boxes shall comply with the Canadian Electrical Code. All boxes shall be clearly marked as part of the automated control system.

.10 Enclosures: All enclosures shall be mounted such that the doors can open fully without interference with new or existing equipment. Except where expressly permitted in writing by the Owner or Engineer, enclosures shall be mounted in easily accessible locations where a technician can clearly see and easily access all components inside without a stool or ladder.

.11 Power Protection: During the warranty period, the Contractor shall be responsible for parts and labour to repair or replace any system equipment damaged by power quality problems (spikes, sags, waveform anomalies, etc.). with that in mind, the Contractor shall provide appropriate power protection.

.12 All wiring shall conform to governing codes and shall be inspected by request of the contractor for approval. The contractor shall obtain and purchase all necessary permits as required.

.13 It is the responsibility of this contractor to provide dedicated 120 V, power from the spare breaker for the automation system from the nearest electrical panel. Provide typewritten information on panel directory.

3.11 BAS DATABASE NAMING CONVENTIONS AND PROGRAMS

.1 Programs Architecture

.1 All BAS programs shall be created in each panel in logical order as determined by the equipment being controlled by each panel on the network. The Outdoor Air Temperature Program shall be in its own program named OAT PG.

.2 The programs shall be created in the following order:

.1 Air Handlers Example: Common for all air handlers and rooftop air handlers.

.1 AH # Start PG – contains all start stop parameters for the air handler.

.2 AH # Setpoint PG – contains all setpoint calculations for the specific air handler.

.3 AH # Control PG – contains all control points for the air handler for both occupied and unoccupied modes.

.4 AH # Zone Setpoint PG – contains all setpoint calculations and limitations for zones serviced by the air handler.

.5 AH # Zone Feedback PG – contains calculation of zone temperature averages, coldest and warmest spaces.

.6 All Rooftop air handlers shall start with the letters RT in the naming conventions.

.2 Boilers, Pumps, and Hydronic Heating Systems Examples:

.1 Heating Enable PG – contains all enable/disable calculations for the entire heating system.

.2 Heating Setpoint PG – contains all setpoint calculations for scheduled water temperatures for both occupied and unoccupied periods.

.3 Heating Control PG – contains control strategies for all heating equipment controlled from the panel.

.4 Pump Control PG – contains control strategies for circulation pumps including pump cycle when heating system is not enabled.

.3 Specialty and Miscellaneous Equipment Programs – specialty equipment with more than three (3) control points, shall be controlled in a separate program and shall be named according to the devices the program controls. The programs for specialty equipment shall be named the following the examples for air handlers and Heating equipment. Miscellaneous equipment with less than three (3) control points may be placed in a program called Misc. PG, and should contain all control parameters in the programs.

.4 Alarm Programs – Each Panel shall have an alarm program for General Warning alarms named P# Alarm PG, and an alarm program for Critical Alarms, named P# Critical PG. The alarms being sent to central monitoring shall be in the panel where the output is connected to the security panel and the programming to activate the Remote Alarm shall be in its own program named Remote Alarm PG.

.5 Point Naming Inputs & Outputs – The listings indicated below are the most common inputs and outputs used in system. Equipment not listed should always indicate clearly the equipment system, function and location in the name if possible. Point naming conventions shall be in upper and lower case for easier readability.

.1 Air Handler Systems Naming Conventions

INPUTS		**OUTPUTS**	
Equipment	**Point Name**	**Equipment**	**Point Name**
Supply Fan Status	AH# SF Status	Supply Fan Control	AH# SF Control
Return Fan Status	AH# RF Status	Return Fan Control	AH# RF Control
Supply Fan Speed Status	AH# SF Spd St	Supply Fan Speed Control	AH# SF Spd Ctrl
Return Fan Speed Status	AH# RF Spd St	Return Fan Speed Control	AH# RF Spd Ctrl
Supply Air Temperature	AH# Supply Temp	Damper Control	AH# Mixed Air Dmpr
Return Air Temperature	AH# Return Temp	Coil Heating Valve Control	AH# Heating Valve
Mixed Air Temperature	AH# Mixed Temp	Cooling Coil Valve Control	AH# Cooling Valve
Return Air C02	AH# Return C02	DX Cooling Stage Control	AH# DX# Control
Air Handler Coil Pump Status	AH# P# Status	Air Handler Coil Pump Control	AH# P# Control
Air Handler Filter Status	AH# Filter	Reclaim Damper Control	AH# Reclaim Dmpr
Air Handler Freezestat Status	AH# Freeze	Reclaim Valve Control	AH# Reclaim Vlv
Reclaim Pump Status	AH# RclP# Stat	Reclaim Pump Control	AH# RclP# Ctrl
Reclaim Temperature Air Entering	AH# Rcl In Temp		
Reclaim Temperature Air Leaving	AH# Rcl Out Temp		
Reclaim Supply Fluid Temperature	AH# Rcl SW Temp		
Reclaim Return Fluid Temperature	AH# Rcl RW Temp		
Duct Pressure	AH# Duct Press		
Building Pressure	Bldg Pressure		

.2 Heating Systems Naming Conventions

INPUTS		**OUTPUTS**	
Equipment	**Point Name**	**Equipment**	**Point Name**
Boiler Status	Blr# Status	Boiler Control	Blr# Control
Outdoor Air Temperature 1	OAT1	Boiler Stage Control	Blr# Stg# Ctrl
Outdoor Air Temperature 2	OAT2	Boiler Modulation	Blr# Modulation
Boiler Pump Status	Blr P# Status	Boiler Pump Control	Blr# P# Control
Heating Pump Status	Heating P# Status	Heating Pump Control	Heating P# Control
Glycol Pump Status	Glycol P# Status	Glycol Pump Control	Glycol P# Control
Heating System Pressure	Htg Pressure	Heating Valve Control	Htg Valve Ctrl
Glycol System Pressure	Gly Pressure		
Heating Supply Water Temperature	Htg Supply Temp		
Heating Return Water Temperature	Htg Return Temp	Heating Differential Pressure Valve	Heating DP Valve
Glycol Supply Water Temperature	Gly Supply Temp	Heat Exchanger Control Valve	HX Vlv ControlGlycol Return
Water Temperature	Gly Return Temp		

.3 Lighting Equipment Naming Conventions

INPUTS		OUTPUTS	
Equipment	**Point Name**	**Equipment**	**Point Name**
Outdoor Photocel	Outdoor Light Levels	Outdoor Light Control	Outdoor Ltg Ctrl
Outdoor Light Override	O/S Lgt Override		
Room Motion Sensor	Rm# Motion	Room Lighting Control	Rm# Ltg Ctrl
Corridor Motion Sensor	Corr# Motion	Corridor Lighting Control	Corr# Ltg Ctrl

.4 Miscellaneous Equipment Naming Conventions

INPUTS		OUTPUTS	
Equipment	**Point Name**	**Equipment**	**Point Name**
Exhaust Fan Status	EF# Status	Exhaust Fan Control	EF# Control
Domestic Hot Water Recirc Pump Status	DHW P# Status	Dom Hot Water Pump Control	DHW P# Control
Urinal Motion Detector	Ur Rm# Motion	Urinal Flush Control	Ur Rm# Control
Electrical Meter	Elect Meter		
Water Meter	Water Meter	Main Water Valve Control	Main Water Vlv
Gas Meter	Gas Meter		
Sump Level Alarm	Sump Alarm		
Area Water Flush Flow	East DWater Flow	Area Domestic Water Flush Control	East DW Flush Ctrl
		Area Flush Flow Alarm Light	East Flush Alarm
Building Security Status	Bldg Security	Building Remote Alarm	Bldg Remote Alarm
Building Override	Bldg Override		

.6 Network Status Panel Naming Conventions should indicate the school, panel location, and panel number. The school name can be abbreviated

END OF SECTION

Division 26 Common Requirements for Electrical

26 00 11 Electrical Specification Index

Common Contract Requirements for Electrical

26 01 13 Electrical Supplemental Tender Form
26 01 15 Electrical Allowances
26 01 16 Electrical Contract General Requirements
26 01 20 Integrated Testing of Fire Protection and Life Safety Systems
26 01 21 Electrical Occupancy Requirements

Common Work Results for Electrical

26 05 19 Wires and Cables
26 05 20 Splitters, Junction, and Pull Boxes
26 05 21 Outlet Boxes, Conduit Boxes, and Fittings
26 05 22 Wire and Box Connectors – 0 –1000 V
26 05 26 Grounding Secondary
26 05 27 Seismic Restraint for Electrical Systems
26 05 33 Conduits, Conduit Fastenings, and Conduit Fittings
26 05 43 Installation of Cables in Trenches and Ducts
26 05 74 Short Circuit/Coordination Study Arc Flash Hazard Analysis
26 05 75 Auxiliary Systems
26 05 76 Electric Heating Systems

Low-Voltage Transformers

26 22 13 Dry Type Transformers

Switchboard and Panelboards

26 24 13 Service Entrance Board
26 24 16 Panelboards
26 24 17 Moulded Case Circuit Breakers

Low-Voltage Distribution Equipment

26 27 26 Wiring Devices

Low-Voltage Circuit Protective Devices

26 28 13 Fuses – Low Voltage
26 28 16 Disconnect Switches

Low-Voltage Controllers

26 29 13 Starters and Contactors

Electrical and Cathodic Protection

26 43 13 Surge Protective Devices

Lighting

26 51 13 Lighting Equipment
26 51 16 Digital Occupancy & Daylight Control Systems

Division 28 Electronic Safety and Security

Fire Detection and Alarm

28 31 25 Fire Alarm System (Addressable)

END OF SECTION

Part 1 General

1.1 INSTRUCTIONS TO BIDDERS

.1 The Electrical Supplemental Tender Form must be submitted to the architect and consultant (admin@deiassociates.ca) within 2 hours after tender closing. Electrical contractors shall identify all sub-contractors he/she intends to use and must complete all information requested. The requisite information shall be given at the office of the Consultant. Contractor shall sign and date this page and initial and date each page thereafter.

.2 Should the Electrical Supplemental Form not be submitted then the contractor shall use Basis of Design manufacturers as listed.

.3 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	

.4 SUB-CONTRACTORS

The Contractor shall state below the name of the Public Address, Security, Co-ordination Study, Computer Network, Life Safety Systems Commissioning Agent, Seismic Restraint Engineer Sub-contractor he intends to use, which shall not be changed without the consent of the Consultant.

Co-ordination Study _____

Seismic Restraint Engineer _____

.5 The Stipulated Bid Sum shall be for the basis of design manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer he intends to use. **Where no choice is indicated, the basis of design supplier or equipment shall be used.**

.6 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified, provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Electrical Contractor shall not indicate equipment, materials or suppliers which are not listed. If this is done, the base bid supplier shall be used.

.7 Where modifications to the work of other trades are required as a result or part of the alternative offered, include the cost of said modifications in the work.

.8 Submit the following list of basis of design and alternative suppliers in accordance with the bid requirements:

Spec. Reference Section	**Equipment**	**Basis of Design**	**Acceptable Alternate Manufacturer**	**Indicate Manufacturer Or Supplier**
26 29 13.13	Starters and Contactors	Schneider Electric	Allen Bradley Siemens Eaton Klockner-Moeller	
26 22 13.13	Dry –Type Transformers	Hammond	Rex Acme Delta Bemag	
26 24 13	Service Entrance Board	Schneider Electric	Siemens Eaton	
26 24 17	Molded Case Circuit Breakers	Schneider Electric	Siemens Eaton	
26 28 16	Disconnect Switches	Schneider Electric	Siemens Eaton	
26 24 16	Panelboards	Schneider Electric	Siemens Eaton	
26 28 13	Fuses – Low Voltage	Mersen	GEC Littlefuse	
26 05 75	Classroom Control Panels	Swift Path	Control Hub Olympic Tool & Die	

26 51 13	LED Interior	Cooper	Lithonia Signify	
26 51 13	LED Exterior	Cooper	Lithonia Signify	
26 51 13	Exit Lighting	Aimlite	Lumacell Stanpro	
26 51 13	Emergency Battery Units	Aimlite	Lumacell Stanpro	
26 51 13	Emergency Fixtures	Aimlite	Lumacell Stanpro	
26 43 13	Surge Protection Devices	Innosys	n/a	
26 05 76	Electric Heating Equipment	Ouellet	Westcan Stelpro	
28 31 25	Fire Alarm System (Addressable)	Edwards	Simplex Notifier Mircom	

.9 LABOUR RATES

.1 The following labour rates shall apply for calculating the cost of credit or extras on Change Notices. The rates shall include any employee benefits. The labour rates do not include overhead and profit.

Apprentice Electrician $_____/hr

Journeymen Electrician $_____/hr

1.2 ELECTRICAL TENDER PRICE (EXCLUDING HST)

.1 Having carefully examined all Drawings and Specifications and the Addenda to the Drawings and Specifications, and having carefully examined the sites and all conditions affecting the work, we, the undersigned thereby offer to provide all plant, labour, materials and incidentals required to complete the work of all trades for: All the work specified for herein for

the Total Stipulated Price of: $_____

_____

(in writing)

in lawful money of Canada; included in which are all applicable excise taxes, custom duties, freight, exchange, and all other charges. HST is not included.

END OF SECTION

Part 1 General

1.1 GENERAL INSTRUCTIONS

.1 Comply with the General Conditions, Supplementary Conditions, and all of Division 1.

.2 Allowances are indicated in Division 1 for this project. Refer to Division 1 to obtain allowance values.

1.2 CASH ALLOWANCE (HST EXCLUDED)

.1 Refer to current CCDC requirement and Division 1 for CASH ALLOWANCES.

.2 HST (Harmonized Sales Tax) is not included in cash allowance(s).

.3 Allowances are stated in Division 1 of this project specification. It is the responsibility of the Electrical Contractor to review all allowances. If no allowances are identified, the Electrical Contract Price shall include all costs associated for the full scope of work and materials related to Electrical Contract Documents prepared by the Consultant.

.4 Allowances shall be expended as the Owner directs through the Consultant. The Consultant will direct the Contractor(s) to **purchase** and perform work for which payment is made from an allowance.

.5 Unless otherwise noted, the stated allowances for equipment purchase include initial distributor mark-up for the material components. The installation of these allowance items, along with required power connections, device boxes, conduit, controls, cabling, cable terminations with testing, making operable, and warranty must be included in the electrical tender price. Therefore, the Contractor shall include any overhead and profit on the allowance value in their tendered price and not from within the allowance value.

.6 Where the actual cost of the Work under any cash allowance is less that the amount of the allowance, the Owner shall be credited for the unexpended portion of the cash allowance, but not for the Contractor's overhead and profit on such amount.

.7 Where the allowance is insufficient to cover the actual cost the difference in value will be addressed as a change order.

.8 The value of the work performed under a cash allowance is eligible to be included in progress payments.

1.3 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.

1.4 CASH ALLOWANCE CONTRACT REQUIREMENTS

.1 The Contractor accepts to provide all contract requirements for the products supplied in the allowances, this includes providing supervision to include the product into the contract, shop drawing submission, coordinating 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

.1 This Section covers items common to Electrical Division 26, as well as Division 27 and Division 28.

.2 This section supplements requirements of Division 1.

.3 Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.

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 electrical 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 TENDERS

.1 Complete Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of tender documents.

.2 Submit Supplemental Tender Form as noted.

.3 Submit tender based on specified described equipment or Alternates listed.

.4 State in Tender, names of all Subcontractors proposed for work under this Division.

1.4 LIABILITY INSURANCE

.1 This contractor must maintain and produce at the request of the consultant proof of proper insurance to fully protect the owner, the consultant and the contractor from any and all claims due to accidents, misfortunes, acts of God, etc.

1.5 ELECTRICAL SAFETY AUTHORITY

.1 The contractor is to determine general inspection fees with Electrical Safety Authority and include as part of tender.

.2 A submission has been made (if required by this scope of project) by the consultant to the Electrical Safety Authority for review of this project. The payment of the required review costs will be coordinated by the consultant. A copy of the Electrical Safety Authority review report will be forwarded to the successful contractor for information and action. Contractor will not be responsible for these review costs.

1.6 DRAWINGS

.1 Electrical 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 conduits and ducts to accommodate structural conditions. Location of conduits and other equipment may be altered by the consultant without extra charge provided change is made before installation and does not necessitate major additional material.

.2 As work progresses and before installing fixtures and 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.

.3 Electrical drawings are diagrammatic. 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. Conceal wiring, 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.

.4 Before commencing work, check and verify all sizes, locations, grades, elevations, levels and dimensions to ensure proper and correct installation. Verify existing/municipal services.

.5 Locate all electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.

.6 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install services so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.

.7 Relocate equipment and/or material installed but not co-ordinated with work of other Sections as directed, without extra charge.

.8 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

1.7 INTERFERENCE AND CO-ORDINATION 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 co-ordinated.

.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 the 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, mechanical, and electrical systems for the consultant's review prior to fabrication.

.2 Detailed equipment room drawings clearly showing all distribution equipment.

.3 Detailed layout drawings clearly showing conduit/feeder runs 78mm diameter or larger, including hangers or tray.

.6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

1.8 QUALITY ASSURANCE

.1 The installations of the division must conform to the latest edition of the Electrical Safety Code as well as its supplemental bulletins and instructions. Provide materials and labour necessary to comply with rules, regulations, and ordinances.

.2 Complete underground systems in accordance with CSA C22.3 No. 7-94 except where specified otherwise.

.3 Abbreviations for electrical terms: to CSA Z85-1983.

.4 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.

1.9 ALTERNATES AND SUBSTITUTIONS

.1 Throughout these sections are lists of "Alternate Equipment" manufacturers acceptable to consultant if their product meets characteristics of specified described equipment.

.2 Each bidder may elect to use "Alternate Equipment" from lists of Alternates where listed. Include for any additional costs to suit Alternated 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" unit is proposed and does not fit space allotted nor equal specified product in consultant's opinion, supply of specified described equipment will be required without change in Contract amount. 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.

1.10 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 Electrical Drawings show general arrangement of fixtures, power devices, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.

.2 Consider Architectural, Mechanical, 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 Electrical 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 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.

1.11 SEQUENCING AND SCHEDULING

.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 electrical items, make proper provision to avoid interferences in a manner approved by consultant. Changes required in work specified in these sections caused by neglect to do so shall be made at no cost to owner.

.3 Arrange fixtures, conduit, ducts, and equipment to permit ready access to junction boxes, starters, motors, control components, and to clear openings of doors and access panels.

.4 Furnish and install inserts and supports required by these sections 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 the electrical trade.

.5 Adjust locations of ducts, conduits, equipment, fixtures, etc., to accommodate work from interferences anticipated and encountered. Determine exact route and location of each conduit and duct prior to installation.

.1 Make offsets, transitions, and changes in direction of ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

.2 Supply and install pull boxes, etc., as required to affect these offsets, transitions, and changes in direction.

1.12 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 and 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

1.13 DRAW BREAKDOWN

.1 This contractor MUST submit a breakdown of the tender price into classifications to the satisfaction of the consultant, with the aggregate of the breakdown totaling the total contract amount. **Each item must be broken out into material and labour costs.** Progress claims, when submitted are to be itemized against each item of the draw breakdown. This shall be done in table form showing contract amount, amount this draw, total to date, % complete and balance.

.2 Breakdown shall be as follows:

.1 Permits and fees
.2 Mobilization (maximum 1%)
.3 Switchboard

.4 Panelboards and miscellaneous distribution equipment
.5 Ductbank primary
.6 Ductbank secondary
.7 Secondary cables
.8 Feeder conduits
.9 Branch conduits
.10 Feeder cables
.11 Branch wiring
.12 Lighting fixtures (interior)
.13 Emergency lighting
.14 Exterior lighting
.15 Lighting Controls Installation
.16 Fire alarm system
.17 Classroom control panels
.18 Starters, contactors, and control devices
.19 Electric heating
.20 Wiring for mechanical equipment
.21 Wiring for owner's equipment
.22 Commissioning (minimum 3%)
.23 Electrical contractor closeout requirements (minimum of 3% but not less than $5,000.00)

.3 The breakdown must be approved by the consultant prior to submission of the first draw.

.4 Breakdowns not complying to the above will not be approved.

.5 Breakdown must indicate total contract amount.

.6 Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.

1.14 SHOP DRAWINGS AND PRODUCT DATA

.1 General

.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 his 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 Manufacturer test data where requested.

.3 Manufacturer to certify as to current model production.

.4 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 If a shop drawing is returned "reviewed as noted" this contractor must provide written indication that the comments have been complied with.

.15 A partial list of shop drawings includes:

.1 High voltage equipment

.2 Switchboards, panelboards and transformers

.3 Fire alarm system

.4 Luminaires and drivers

.5 Emergency battery units, exit signs, and fixtures

.6 Electrical heaters
.7 Classroom control panels
.8 Heat loss replacement cabling equipment
.9 Starters, contactors, and control devices
.10 Firestopping materials
.11 Hand dryers
.12 Wiring devices
.13 Cable management hangers
.14 Cable management system
.15 Lighting controls
.16 Digital time switch
.17 Disconnect switches and fuses
.18 Surge protection devices
.19 Grounding system components
.20 Destratification fans and associated controls
.21 Roof cone
.22 Miscellaneous enclosures
.23 Co-ordination study and arc flash hazard analysis
.24 Seismic restraint study

.2 Submissions 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.

1.15 CARE, OPERATION AND START-UP

.1 Instruct consultant and operating personnel in the operation, care and maintenance of equipment.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation and ensure that operating personnel are conversant with all aspects of its care and operation.

1.16 VOLTAGE RATINGS

.1 Operating voltages: to CAN3-C235-83.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.17 PERMITS, FEES, AND INSPECTION

.1 A submission has been made (if required by this scope of project) by the consultant to the Electrical Safety Authority for review of this project. The payment of the required review costs will be co-ordinated by the consultant. A copy of the Electrical Safety Authority review report will be forwarded to the successful contractor for information and action.

.2 The contractor is required to include in his tender all required inspection costs by the Electrical Safety Authority. Permit application is the responsibility of the contractor.

.3 Reproduce drawings and specifications required by Electrical Safety Authority at no cost.

.4 Notify consultant of changes required by Electrical Safety Authority prior to making changes.

.5 Furnish Certificates of Acceptance to consultant from Electrical Safety Authority and other authorities having jurisdiction upon completion of work.

.6 This contractor must furnish any certificates required to indicate that the work completed conforms with laws and regulations of authorities having jurisdiction.

1.18 ADDITIONAL INSTALLED EQUIPMENT

.1 The electrical contractor is to review all specification sections forming part of the electrical bid documents and include additional equipment or components, as well as all associated installation costs and testing costs as noted, in the electrical bid price.

1.19 MATERIALS AND EQUIPMENT

.1 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Safety Authority.

.2 Factory assemble control panels and component assemblies.

1.20 ELECTRIC MOTORS, EQUIPMENT, AND CONTROLS

.1 Supplier and installer responsibility is indicated in the Equipment Wiring Schedule on electrical drawings.

.2 Control wiring and conduit is specified in the Electrical specifications except for conduit, wiring and connections below 50 V, which are related to control systems specified in the Mechanical specifications.

1.21 FINISHES

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

.1 Paint outdoor electrical equipment "equipment green" finish.

.2 Paint indoor switchgear and distribution enclosures light grey.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed non-galvanized hangers, racks, fastenings, and conduits etc. to prevent rusting.

1.22 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.2 Nameplates:

.1 Lamicoid 3 mm (1/8") thick plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.

NAMEPLATE SIZES

Size 1	9 mm x 50 mm (3/8" x 2")	1 line	3 mm (1/8") high letters
Size 2	12 mm x 70 mm (1/2" x 2 1/2")	1 line	5 mm (3/16") high letters
Size 3	12 mm x 70 mm (1/2" x 2 1/2")	2 lines	3 mm (1/8") high letters
Size 4	20 mm x 90 mm (3/4" x 3 1/2")	1 line	9 mm (3/8") high letters
Size 5	20 mm x 90 mm (3/4" x 3 1/2")	2 lines	5 mm (3/16") high letters
Size 6	25 mm x 100 mm (1" x 4")	1 line	12 mm (1/2") high letters
Size 7	25 mm x 100 mm (1" x 4")	2 lines	6 mm (1/4") high letters

.3 Wording on nameplates labels to be approved by consultant prior to manufacture.

.4 Allow for average of twenty-five (25) letters per nameplate.

.5 Identification to be English.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Nameplates for disconnects, starters and contactors must indicate equipment being controlled and voltage.

.8 Nameplates for transformers must indicate transformer label as indicated and capacity, primary, and secondary voltages.

1.23 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

1.24 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m (45') intervals.

.3 Colour bands must be 25 mm (1") wide.

	Prime
up to 208 V	yellow
209 to 600 V	white
Voice system	green
Data system	orange
Security	brown
Public address	black
Cable TV	blue
Fire alarm	red

.4 This contractor must paint all system junction boxes and covers in conformance with the above schedule.

1.25 PROTECTION OF OPENINGS

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

1.26 WIRING TERMINATIONS

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

1.27 MANUFACTURERS AND CSA LABELS

.1 All labels must be visible and legible after equipment is installed.

1.28 WARNING SIGNS

.1 To meet requirements of Electrical Safety Authority and consultant.

.2 Provide porcelain enamel signs, with a minimum size of 175 mm x 250 mm (7" x 10").

1.29 LOCATION OF OUTLETS

.1 Do not install outlets back-to-back in wall; allow minimum 150 mm (6") horizontal clearance between boxes.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3 m (10'), and information is given before installation.

.3 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

1.30 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of 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 electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1100 mm (43.3").

.2 Wall receptacles:

.1 General: 400 mm (16").

.2 Above top of continuous baseboard heater: 200 mm (8").

.3 Above top of counters or counter splash backs: 100 mm (4").

.4 In mechanical rooms: 1200 mm (48").

.3 Panelboards: as required by Code or 1400 mm (56").

.4 Voice/Data outlets: At height of adjacent outlet or at 400 mm (16").

.5 Fire alarm stations: 1200 mm (3'-11").

.6 Fire alarm visual and signal devices: 2250 mm (88 ½").

.7 Television outlets: 400 mm (16").

.8 Thermostat: 1200 mm (3'-11").

.9 Clocks: 2100 mm (84").

.10 Heaters: 200 mm (8" AFF) to bottom of heater.

.11 Emergency call switches and/or pushbuttons: 900 mm (36").

1.31 LOAD BALANCE

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

1.32 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm (2") beyond either side.

.2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

1.33 FIELD QUALITY CONTROL

.1 Conduct and pay for following tests:

.1 Power distribution system including phasing, voltage, grounding, and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.5 Systems: fire alarm system, communications, security.

.2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.3 Insulation resistance testing.

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of consultant.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for consultant's review.

1.34 EQUIPMENT NAMEPLATE DATA

.1 Refer to the Equipment Wiring Schedule, Distribution Diagram(s) and Panel Schedules for information regarding the designed electrical connections for all equipment to be connected to the electrical distribution system.

.2 Refer to the shop drawing submissions of all project divisions and coordinate with all trades and equipment manufacturers throughout the construction period for equipment connection requirements.

.3 This electrical trade shall be responsible to coordinate any discrepancies on equipment minimum circuit ampacity, maximum overcurrent protection, voltage and phase, between the equipment manufacturer published literature, the equipment shop drawing submission, the project design drawings equipment wiring schedule, and the nameplate data on the equipment. The contractors installing and connecting all equipment shall be responsible for the coordination of this data through the construction period.

.4 Equipment shall not be connected where the specified maximum overcurrent protection and minimum circuit ampacity values do not meet the requirements of the equipment nameplate data on site.

.5 Electrical distribution equipment shop drawings shall not be submitted prior to approval of equipment to be connected including, but not limited to, mechanical units, pumps, elevators, etc. Electrical distribution equipment shall not be released into production until all connected equipment requirements are confirmed and included in approved shop drawings.

.6 Where nameplate data of equipment on site varies from that data listed in the approved equipment shop drawings, the consultant shall be notified in writing, and the equipment shall not be connected until the equipment connection details are confirmed. The final installation must meet the nameplate data of the equipment on site.

.7 No subsequent allowance for time or money for changes to breakers, wiring and conduit, or equipment sizes will be considered for any consequence related to failure by the electrical trade to coordinate final equipment connection requirements with nameplate data and electrical distribution equipment shop drawings.

1.35 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as indicated on drawings or as determined from co-ordination study.

.2 Electrical connections to all equipment requiring connection to the electrical distribution system as part of this electrical tender have been specified according to the anticipated equipment manufacturer electrical requirements and the applicable sections of the OESC. This contractor must coordinate electrical connections to all equipment specified to be connected as part of this electrical tender.

.3 Prior to submitting electrical distribution shop drawings to the consultant, review all shop drawings for all equipment specified for connection to the electrical distribution system to verify that the product electrical connection requirements listed by the manufacturer conform to the equipment electrical connections specified on the electrical design drawings and specifications. Make necessary revisions to breaker ratings associated with the review of all product shop drawings and identify such changes as part of the electrical distribution equipment shop drawing submission.

.4 Prior to making final equipment connections, this electrical contractor shall examine equipment nameplates at the project site to confirm voltage and phase requirements, minimum circuit ampacity and maximum overcurrent protection values, and bring to the attention of the consultant in writing any connection requirements which may vary from the designed connections or approved electrical distribution shop drawings. No subsequent allowance for time or money for changes to breaker or wire and conduit sizes will be considered for any consequence related to failure to examine site conditions.

1.36 GUARANTEE AND WARRANTY

.1 At ready for takeover of this project this Contractor must provide a written guarantee indicating that any defects, not due to ordinary wear and tear or improper use which occur within the first year from the date of ready for takeover will be corrected at the contractor's expense.

.2 If the electrical sub-contractor's office is 50 kilometers (30 miles) or more from the project site, the sub-contractor is to provide a service/warranty work agreement for warranty period with a local electrical sub-contractor approved by consultant. Include copy of service/warranty agreement in warranty section of operation and maintenance manual.

.3 Warranty period shall start from date of ready for takeover completion.

.4 Refer to individual specification sections for information on any special manufacturer's equipment warranties.

1.37 SYSTEM START UP

.1 Provide consultant with written notice verifying all equipment operation and installation is complete prior to scheduled start-up period.

.2 Start up shall be in presence of the following: owner or representative, contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by consultant.

.3 Arrange with all parties and provide 72 hours notice for start up procedure.

.4 Simulate system start up and shut down and verify operation of each piece of equipment.

.5 These tests are to demonstrate that the systems and equipment installed are operational as specified.

.6 The contractor must describe during the start up session the required maintenance for each piece of equipment according to the manufacturer.

.7 The contractor must provide all necessary tools (including a digital multimeter) to successfully complete the start up procedure.

1.38 OPERATION AND MAINTENANCE MANUAL

.1 Provide operation and maintenance data for incorporation into manual as specified in other Sections of this Division.

.2 Operation and maintenance manual to be approved by, and final copies deposited with, consultant before final inspection.

.1 Submit one (1) copy of Operation and Maintenance Manual to consultant for review and 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 hard copy.

.1 Electronic submission/PDF file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.

.2 Hard copy 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.

.2 Make changes as required and re-submit as directed by consultant.

.3 Each manual must include (in "tabbed" sections) the following:

.1 Index

.2 List of General, Mechanical, Electrical Contractors and all associated sub-contractor names, addresses and contact numbers.

.3 List of suppliers and equipment wholesalers local to the project.

.4 Letter of contractor's warranty and guarantee for all parts, equipment and workmanship.

.5 List of manufacturers, spare parts list and source.

.6 Copy of typewritten schedules for all new and renovated panels.

.7 Copy of all substantial performance final certificates.

.8 Copy of electrical shop drawings which have been stamped and reviewed by consultant.

.9 Electrical As-built drawings including contractor company's as built stamp.

.10 Coordination study/Arc flash hazard study shop drawings

.11 Any special warranties on equipment required (i.e. LED lighting, digital lighting control, SPDs, power generation).

.12 Certificate of completion from all associated sub-contractors.

.13 Cable test results and floor plans containing address labels.

.14 System commissioning certificate and report.

.4 Final Submittals:

.1 Upon acceptance of Operation and Maintenance Manual by the consultant, provide the following:

.1 Provide one (1) copy of final Operation and 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.

1.39 AS-BUILT DRAWINGS

.1 Site records:

.1 Contractor shall provide two (2) sets of reproducible electrical 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 field and contract changes to electrical systems.

.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 submittal for review:

.1 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 ELECTRICAL SYSTEMS AS INSTALLED" (Company Name) (Signature of Contractor) (date).

.2 Submit copy to consultant for approval. When returned, make corrections (if any) as directed.

.3 As-built drawings final submittal:

.1 Once approved, submit completed, reproducible paper as-built drawings as well as a scanned PDF file copy on USB stick with Operation and Maintenance Manuals.

1.40 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

.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 Manufacturers or their representatives are to provide demonstrations and instructions.

.3 Use operation and maintenance manual, As-built drawings, audio visual aids, etc. as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Where deemed necessary, consultants may record these demonstrations on video tape for future reference.

1.41 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
.5 Coordination Study / Arc Flash Hazard (including photos of each breaker)
.6 Lighting Control System
.7 Auxiliary Systems (A/V systems, SPDs, etc.)
.8 Outlet cover circuit labels

1.42 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.

1.43 REVISION TO CONTRACT

.1 Provide the following for each item in a given change notice:

.1 Itemized list of material with associated costs.
.2 Labour rate and itemized list of labour for each item.
.3 Copy of manufacturers/suppliers invoice if requested.

1.44 EQUIPMENT SUPPORTS

.1 Equipment supports supplied by equipment manufacturer: shall be installed by the electrical contractor.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings if necessary.

.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. This installation of this pad shall be the responsibility of the electrical contractor.

.4 This contractor shall be responsible for providing all anchor bolts and associated formed concrete bases for lighting standards as detailed.

1.45 SLEEVES

.1 Pipe sleeves: at points where pipes pass through masonry, concrete, or fire rated assemblies and as indicated.

.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.

.4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and conduit.

.5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.

.6 Through foundation walls PVC sleeves are acceptable.

.7 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 Fill future-use sleeves with easily removable filler.

1.46 FIRESTOPPING

.1 Firestopping material and installation within annular space between conduits, ducts, and adjacent fire separation.

.2 Provide materials and systems capable of maintaining effective barrier against flame, smoke, and gases.

.3 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.

.4 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation.

.5 Provide "firewrap" blanket around services penetrating firewalls. Extent of blanket must correspond to ULC recommendations. In general wrap individual conduits with approved firewrap materials on each side of firewall. Refer to architectural drawings for FT ratings. Provide 1 and/or 2 layers of firewrap with transverse and longitudinal seams overlapped and/or butted (second layer offset from first layer). Cut edges are to be sealed with aluminum foil tape. Provide 50 mm stainless steel banding at 200 mm intervals. Install firewrap to manufacturers' recommendations for proper FT rating. Acceptable manufacturers are 3M Firemaster ductwrap or approved equal.

.6 The firestopping materials are not to shrink, slump or sag and be free of asbestos, halogens and volatile solvents.

.7 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.

.8 Firestop materials are to be capable of receiving finish materials in those areas, which are exposed and scheduled to receive finishes.

.9 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.

.10 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.

.11 Submit product literature and installation material on firestopping in shop drawing and product data manual.

.12 Acceptable manufacturers:

.1 Rectorseal Corporation (Metacaulk)

.2 Proset Systems

.3 3M

.4 Hilti

.5 STI Firestop

Note: Fire stop material must conform to requirements of local authorities having jurisdiction. Contractor to confirm prior to application and ensure material used is compatible with that used by other trades on site.

1.47 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 Prime and touch up marred finished paintwork to match original.

.4 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.

1.48 ACCESS DOORS

.1 Supply access doors to concealed electrical equipment for operating, inspecting, adjusting and servicing.

.2 Flush mounted 600 mm x 600 mm (24" x 24") for body entry and 300 mm x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180º, 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 Installation:

.1 Locate so that concealed items are accessible.

.2 Locate so that hand or body entry (as applicable) is achieved.

.3 Installation is specified in applicable sections.

.5 Acceptable materials:

.1 Le Hage

.2 Zurn

.3 Acudor

.4 Nailor Industries Inc.

1.49 DELIVERY STORAGE & 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 mechanical injury, but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.

1.50 REPAIR, CUTTING, CORING AND RESTORATION

.1 Be responsible for required digging, 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.

.2 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.

.3 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.

.4 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

.5 Slots, cores 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.

1.51 CLEANING

.1 Clean interior and exterior of all electrical equipment provided including light fixture lenses.

.2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

1.52 OWNER SUPPLIED EQUIPMENT

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

.2 Design drawings are diagrammatic and do not necessarily indicate all specific final connection requirements. For the purposes of bidding, electrical trade shall include but not be limited to provision of a junction box to connect equipment wiring tail, provision of suitable disconnecting means, and flexible connection directly to equipment.

1.53 ENCLOSURES

.1 This contractor must ensure that all electrical equipment mounted in sprinklered areas is provided with an enclosure in conformance with the Electrical Safety Code.

1.54 ELECTRICAL SYSTEMS COMMISSIONING

.1 This electrical contractor shall work with the building commissioning agent to perform commissioning of all electrical systems.

1.55 INTEGRATED LIFE SAFETY SYSTEM TESTING

.1 The Integrated Life Safety System Testing Coordinator (ITC) shall be hired by the GC as indicated in the Division 1 specifications.

.2 This electrical contractor shall work with the project Integrated Life Safety System Testing Coordinator (ITC) and participate in all phases of the Integrated Life Safety Systems testing process as specified within CAN/ULC S1001-11 (2024 Rev2 updates) as well as the electrical and architectural specifications.

.3 During the ***Planning Phase*** of the Integrated Life Safety Systems Testing process this electrical contractor shall review the Integrated Testing Plan (ITP) and give written confirmation of this review and acknowledgement of affected systems under his responsibility as required by the electrical specifications per the shop drawing submittal process.

.4 Prior to the building Integrated Life Safety Systems Testing this electrical contractor shall startup/commission/verify the operation of all systems under the responsibility of this electrical trade. This electrical trade shall give written indication of completed systems and provide copies of all inspection reports, start-up reports, commissioning reports, verification reports, etc. when requested by the ITC during the ***Implementation Phase***.

.5 Upon completion of the building Integrated Life Safety Systems Testing this electrical contractor shall rectify all deficiencies related to all systems under his responsibility during the ***Testing Phase*** in due time for the ITC to verify and document for the project team.

Part 2 **Not Used**

Part 3 **Not Used**

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Section 21 02 51 – FIRE PROTECTION GENERAL REQUIREMENTS and DIVISION 1

.2 Section 21 12 13 – FIRE SUPPRESSION STANDPIPE SYSTEM

.3 Section 21 13 13 – WET PIPE FIRE SUPPRESSION

.4 Section 21 22 11 – CLEAN AGENT FIRE SUPPRESSION SYSTEM and DIVISION 1

.5 Section 23 02 52 – HVAC GENERAL REQUIREMENTS and DIVISION 1

.6 Section 23 33 17 – SMOKE CONTROL DAMPERS

.7 Section 26 01 16 – ELECTRICAL GENERAL REQUIREMENTS and DIVISION 1

.8 Section 26 51 13 – LIGHTING EQUIPMENT

.9 Section 26 51 16 – DIGITAL OCCUPANCY & DAYLIGHT CONTROL SYSTEMS

.10 Section 28 31 25 – FIRE ALARM SYSTEM (ADDRESSABLE)

.11 Applicable building systems in item 1.3.10 and as included in all project DIVISIONS.

1.2 REFERENCES

.1 OBC-2024, Ontario Building Code Compendium.

.2 CAN/ULC-1001, Integrated System Testing of Fire Protection and Life Safety Systems.

.3 CAN/ULC-S524, Installation of Fire Alarm Systems.

.4 CAN/ULC-S537, Verification of Fire Alarm Systems.

.5 CAN/ULC-S573, Installation of Ancillary Devices Connected to Fire Alarm Systems

.6 CAN/ULC-S561, Installation and Service for Fire Signal Receiving Centres and Systems

.7 CAN/ULC-S112, Standard Method of Fire Test of Fire Damper Assemblies

.8 NFPA 13, Fire Sprinkler Systems

.9 NFPA 17A, Standard for Wet Chemical Extinguishing Systems

.10 NFPA 92, Standard for Smoke Control Systems

.11 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

1.3 OVERVIEW

.1 All work shall be performed in accordance with CAN/ULC-1001 Integrated System Testing of Life Safety and Fire Protection Systems, latest edition.

.2 The Building Code has adopted CAN/ULC-1001 as the standard to comply with Integrated System Testing of Life Safety and Fire Protection Systems. The scope of this project shall follow the strict guidelines laid out in CAN/ULC-1001 for Integrated Testing Planning, review, and implementation.

.3 The Integrated Testing Plan (ITP) will provide a full overview of all integration points of life safety and fire protection systems. The ITP will be submitted for review to the design professionals and Authority Having Jurisdiction (AHJ). Upon the successful completion of the ITP and all the respective systems, the Integrated Testing Coordinator (ITC) will provide a schedule to the design professionals, the AHJ, and all required participating members for the ITP to be conducted.

.4 The ITC will review all drawings, specifications, sequence of operations, and methodology prepared by the design professionals, complete with the contractor's shop drawings and manufacture requirements.

.5 The ITP shall be coordinated with all sub-contractors and suppliers as outlined in item 1.1.

.6 The ITC will conduct the ITP and will sign each integrated test form, complete with signatures from each participating member of the integrated systems.

.7 The ITC shall witness all integrations and not rely on the CAN/ULC-S537 Verification Inspection Report for fire protection system integration testing; however, the ITC may attend the verification to validate the testing.

.8 The ITC will provide all work and ITP including functional documentation, prescribed in CAN/ULC-1001. Such testing and documentation have been deemed to satisfy OBC 2024 Sentence 3.2.9.

.9 The ITC will provide PDF and digital media copy of the buildings ITP and Integrated System Report (ITR) for the building owner's use, re-testing, and reproduction purpose.

.10 The systems applicable to the function testing include but not limited to:

- .1 Fire Alarm System (including sequence of operations) and Monitoring
- .2 Elevators
- .3 Sprinkler Systems (wet, dry, window, garbage chute, standpipe)
- .4 Kitchen Fire Suppression Systems
- .5 Fixed Fire Suppression Systems
- .6 Magnetic Door Holds
- .7 Fire Curtain or Fire Shutter Release
- .8 Smoke and CO Alarms
- .9 Smoke Damper Assemblies
- .10 HVAC Shutdown
- .11 A/V System Mute/Shutdown
- .12 HVLS Fan Shutdown

Part 2 Products

2.1 TESTING AND PLANNING

.1 The Integrated Testing Process must include following:

- .1 Planning phase by the testing coordinator.

.2 Integrated testing plan review by the design professionals.

.3 Integrated testing plan review by the AHJ.

.4 Review of sequence of operations.

.5 System documentation.

.6 Integrated System Testing Plan consisting of:

.1 Project description.

.2 Project contacts including applicable project responsibilities.

.3 Overview and description of each integrated system.

.4 System integrations and functional objective of each integrated system.

.5 Integration matrix of all integrated system complete with integration type, normal mode and off-normal mode.

.6 Test protocols and procedures of each integrated system,

.7 Notifications.

.8 Personnel safety.

.9 Phased occupancies.

.10 Pre-testing documentation checklist.

.11 Pre-testing documentation acknowledgement forms.

.12 Testing forms.

.13 Ongoing integrated system testing forms.

.14 Integrated system testing completion form.

.15 Integrated testing notes.

2.2 RESPONSIBILITIES

.1 General Contractor:

.1 General Contractor to employ the services of the ITC firm as a sub-contractor and include in bid price. Refer to item 2.6.

.2 Coordinate with the ITC for schedule and witness testing.

.3 Coordinate all responsible sub-contractors.

.4 Confirm all respective systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.

.5 Provide reports for respective systems such as, but not limited to; TSSA elevator inspection reports, start-up reports, commissioning reports, verification reports.

.6 Participate in the ITP and provide function testing of equipment within the mechanical, electrical, and fire protection contract packages.

.7 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.

.8 Allow for any cost associated with phased occupancy and phased Integrated Testing work.

.2 HVAC Contractor:

.1 The HVAC Contractor shall confirm all mechanical systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.

.2 Provide system reports such as, but not limited to; air balancing reports, TSSA inspection reports, start-up reports, commissioning reports, verification reports. The Mechanical Contractor shall further provide written confirmation that all mechanical systems are installed and operating as intended by the contract documents and sequence of operations.

.3 Participate in the ITP and provide function testing of equipment within the mechanical contract package.

.4 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.

.5 Allow for any cost associated with phased occupancy and phased Integrated Testing work.

.3 Fire Protection Contractor:

.1 The Fire Protection Contractor shall confirm all fire protection systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.

.2 Provide system reports such as, but not limited to; NFPA 13 letter, NFPA 20, letter, above ground sprinkler piping letter, below ground sprinkler letter, system designer letter, start-up reports, commissioning reports, verification reports. The Fire Protection Contractor shall further provide written confirmation that all fire protection systems are installed and operating as intended by the contract documents and sequence of operations.

.3 Participate in the ITP and provide function testing of equipment within the fire protection contract package.

.4 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.

.5 Allow for any cost associated with phased occupancy and phased Integrated Testing work.

.4 Electrical Contractor:

.1 The electrical contractor shall confirm all electrical systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.

.2 Provide system reports such as, but not limited to; ESA Inspection Certificate, Fire Alarm Verification, TSSA Inspection, Generator Start-up report, commissioning reports, and verification reports. The Electrical Contractor shall further provide written confirmation that all electrical systems are installed and operating as intended by the contract documents and sequence of operations.

.3 Participate in the ITP and provide function testing of equipment within the electrical contract package.

.4 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.

.5 Allow for any cost associated with phased occupancy and phased Integrated Testing work.

.5 Equipment Manufacturers:

.1 Where required, shall confirm all respective systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.

.2 Participate in the ITP and provide function testing of equipment within the respective contract package.

.6 Design Professionals:

.1 The design professional shall include, but not be limited to, the project Architect, Electrical and Mechanical Consultants, Fire Protection Engineer, Elevator Consultant, etc.

.2 Shall review the ITP, and upon review, accept the ITP as the agreed ITP for implementation.

.3 The design professionals are responsible for design. Upon an unsuccessful test, the failure will be documented and provided to the respective design professionals for review and action.

2.3 NOTIFICATION OF TESTING PLANNING PROCESS

.1 The ITC shall work with the General Contractor, Owner, sub-contractors, design professionals, and the AHJ to provide a schedule for the implementation of the ITP.

.2 The ITC shall obtain contact names, contact details, and system responsibilities for all project design professionals.

.3 The ITC shall provide notification to the integrated testing participants seven (7) days prior to the date and time for the implementing of the ITP.

.4 Prior to testing, the ITC shall obtain written acknowledgement for acceptance and understanding of the ITP by all project design professionals and contractors per 1001 Section 5 and Appendix B. Include ITP Review & Acceptance acknowledgement sheet in the ITR. **Refer to Figure 1.**

.5 Prior to testing, the ITC shall obtain written acknowledgement for acceptance testing of site readiness from all project design professionals and contractors per 1001 Section 5 and Appendix B. Failure to obtain acknowledgement prior to implementation of integrated testing may invalidate the results and could result in delays by the design professionals issuing conformance. Include ITP Acceptance Testing acknowledgement sheet in the ITR. **Refer to Figure 2 and Figure 3.**

.6 In the event of building occupants, the ITC shall provide at a minimum, forty-eight (48) hour notice of the implementation of the integrated testing. Notification shall be provided via written notices posted at each building entrance.

.7 Partial occupancies shall employ this process for each individual occupancy and shall clearly identify the extent of to which the partial occupancy applies when obtaining written confirmations.

.8 Figures 1 through 3 of this specification section are indicated as informative and are for information only regarding the intent for required written acknowledgement gathering by the ITC. All designers and trades listed may not apply to all projects. The ITC shall be responsible for determining all required designers and contractors for the project based on the contact information from the ITP.

2.4 TESTING IMPLEMENTATION PROCESS

.1 Implementation of the integrated test shall follow all job site and personnel safety requirements set out in the contract and General Contractors requirements.

.2 The ITC shall define:

.1 Personnel safety protocols

.2 Special hazards

.3 Team communications

.4 Occupant notification of emergencies

.3 The integrated system test shall follow the methodology and process outlined in CAN/ULC-1001 as the requirement for this project.

.1 Provide the final ITP to the Consultant fourteen (14) days prior to scheduled implementation and test.

.4 The respective contractors and manufactures are responsible to start-up and function test their respective systems, for observation and witnessing by the ITC. The ITC will record the results, and the respective contractor and manufacture will restore the system to a normal condition. Upon successful testing the contractor and manufacture will initial the respective integrated testing from adjacent to their respective test.

.5 Upon a failure of a test, the ITC will document the failure and continue with the testing of other integrations. The respective contractor and manufacture will document the failure, notify they design professional, and correct the failure under the direction of the design professional.

.1 The ITC will re-test the unsuccessful integration after the correction has been documented and verified.

.6 Upon a failure of a device (such as a smoke detector), the contractor may immediately replace the device, and the ITC may continue to test the integration. The device failure maybe documented but shall not result in a failed integrated test.

.7 The ITC shall include in quote costs associated with site testing of all integrated devices. ITPs and testing procedures which include only for a sampling of devices will not be accepted. ITPs and testing procedures which rely solely on inspection reports, start-up reports, commissioning reports, or verification reports, etc. will not be accepted.

.8 Partial occupancies shall employ this process for each individual occupancy and shall clearly identify the extent to which the partial occupancy applies when obtaining written confirmations.

.9 Upon successfully completing the ITP, the ITC shall provide the ITR to the design professionals and building owner.

2.5 QUALITY CONTROL

.1 The ITC must meet the following criteria to be considered acceptable for this project:

.1 Firms regular engaged with contractors in function testing, fire alarm verification, sprinkler system testing, annual inspections and maintenance of fire and life safety systems.

.2 Firms knowledgeable and experience of the respective Codes and Standards of the particular project, including but not limited to; Building Codes, Fire Codes, ULC Standards, CSA Standards, and NFPA Standards.

.3 Firms must be a member in good standing of the Canadian Fire Alarm Association (CFAA).

.4 Vendors must be a 3rd party and independent from the fire protection and life safety system installation company present on the project in accordance with ULC Certification Bulletin 2020-08.

.5 Firms must maintain operations in the province of Ontario for at least five years.

.6 Vendors must be a ULC Listed Integrated Systems Testing Service Provider and posses a ULC Integrated Fire Protection and Life Safety Certification. The ULC Certificate must be valid from the date of project award until the completed Integrated Testing Report. The ULC certification level shall be that which is applicable to the building life safety systems level of complexity for the project.

.1 Submit the ULC Certificate upon project award to the Consultant's office complete with Applicant ID Number.

2.6 QUALIFIED INTEGRATED TESTING COORDINATOR

.1 Bidders may choose from the experienced ITC Firms listed below or local branches of these companies noted in the vicinity of this project and are acceptable as a sub-contractor to the Electrical Contractor:

.1 Lonergan Engineering
Aurora, Ontario L4G 3V5

.2 Great Lakes Fire Consulting & Engineering Group
Windsor, Ontario

.2 Other experienced ITC Firms must submit in writing, to the Consultant's office, confirmation of the items listed in the Quality Control criteria above, prior to tender close to be considered as an acceptable bidder.

END OF SECTION

Figure 1 – Example Pre-Test ITP Acknowledgement (Typical Design Professionals): Informative

INTEGRATED SYSTEMS WRITTEN ACKNOWLEDGEMENT REVIEW AND ACCEPTANCE OF INTEGRATED TEST PLAN (EXAMPLE)			
Per Item 5.2.8 and Section B9.1 of CAN/ULC S1001 (latest version), the respective design professionals shall indicate written confirmation to the Testing Coordinator acceptance of the Integrated systems Test Plan according to the intent of the project design documents.			
List of Design Professionals		Company/Representative	Design Responsibility
Architect	Company Name:		
	Designer Name:		
	Signature		
Electrical Engineer	Company Name:		
	Designer Name:		
	Signature		
Mechanical Engineer	Company Name:		
	Designer Name:		
	Signature		
Fire Protection Engineer (sprinkler)	Company Name:		
	Designer Name:		
	Signature		
(typical responsible consultant on project)	Company Name:		
	Designer Name:		
	Signature		

Figure 2 – Example Pre-Test Trade Site Ready Acknowledgement (Typical Project Trades): Informative

PRE-TESTING INTEGRATED SYSTEMS WRITTEN ACKNOWLEDGEMENT (EXAMPLE)			
Per Item 5.3.1.(B) and Section B8.1 of CAN/ULC S1001 (latest version), the respective installing contractors shall indicate written confirmation to the Testing Coordinator that their respective life safety systems have been installed in accordance with the design are ready for integrated testing as outlined within the Integrated Systems Testing Plan.			
List of Installing Trades		Company/Representative	System Responsibilities
General Contractor	Company Name:		
	Name:		
	Signature		
Electrical Contractor	Company Name:		
	Name:		
	Signature		
Mechanical Contractor	Company Name:		
	Name:		
	Signature		
Sprinkler Contractor	Company Name:		
	Name:		
	Signature		
Elevator Contractor	Company Name:		
	Name:		
	Signature		
(typical responsible trade on project)	Company Name:		
	Name:		
	Signature		

Figure 3 – Example Pre-Test Designer Site Ready Acknowledgement (Typical Design Professionals): Informative

PRE-TESTING INTEGRATED SYSTEMS WRITTEN ACKNOWLEDGEMENT (EXAMPLE)			
Per Item 5.3.1.(A) and Section B8.1 of CAN/ULC S1001 (latest version), the respective design professionals shall indicate written confirmation to the Testing Coordinator that the site is ready for integrated systems testing per the descriptions and integrations outlined within the Integrated Systems Testing Plan.			
List of Design Professionals		Company/Representative	Design Responsibility
Architect	Company Name:		
	Designer Name:		
	Signature		
Electrical Engineer	Company Name:		
	Designer Name:		
	Signature		
Mechanical Engineer	Company Name:		
	Designer Name:		
	Signature		
Fire Protection Engineer (sprinkler)	Company Name:		
	Designer Name:		
	Signature		
(typical responsible consultant on project)	Company Name:		
	Designer Name:		
	Signature		

Part 1 General

1.1 GENERAL

.1 This Section covers items common to Electrical Division 26, as well as Division 27 and Division 28.

.2 This section supplements requirements of Division 1.

1.2 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 Electrical Safety Authority.

.2 Emergency Lighting.

.3 Smoke Alarm and Carbon Monoxide Detector Alarm.

.4 Testing of Integrated Fire Protection and Life Safety Systems Report.

.5 Electrical Seismic Restraint Engineers' Letter.

.6 Fire Alarm Verification Certificate.

Part 2 Not Used

Part 3 Not Used

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.2 No.0.3-92, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No.131-M89(R1994), Type TECK 90 Cable.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger.

.2 Minimum size: 12 AWG.

.3 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material 90°C (194ºF) rated T90 for indoor above grade installations and RW90 for below grade installations.

2.2 TECK CABLE

.1 Cable: to CAN/CSA-C22.2 No.131.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Inner jacket: polyvinyl chloride material.

.4 Armour: aluminum.

.5 Overall covering: polyvinyl chloride material.

.6 Fastenings:

.1 One hole steel zinc straps to secure surface cables 50 mm (2") and smaller. Two hole steel straps for cables larger than 50 mm (2").

.2 Channel type supports for two or more cables at 1500 mm (60") centres.

.3 Threaded rods: 6 mm (1/4") diameter to support suspended channels.

.7 Connectors must be suitable for:

.1 Installed environment and approved for use with TECK cable.

2.3 ARMOURED CABLES

.1 Conductors: insulated, copper minimum size as indicated above.

.2 Type: AC90 (minimum size 12 AWG).

.3 Armour: interlocking type fabricated from aluminum strip.

.4 Connectors must be suitable for installed environment and approved for use with armoured cable.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

.1 Install wiring from source to load through raceways as specified.

.2 Provide separate neutral conductors for all lighting circuits and circuits originating from surge protected panels. Size raceways accordingly.

3.2 INSTALLATION OF TECK CABLE 0 - 1000 V

.1 Group cables wherever possible on channels.

.2 Terminate cables in accordance with Wire and Box Connectors - 0 - 1000 V Section.

3.3 INSTALLATION OF MINERAL INSULATED CABLES

.1 Run cable exposed, securely supported by straps and hangers.

.2 Support 2 h fire rated cables at 1 m (39") intervals.

.3 Make cable terminations by using factory-made kits.

.4 At cable terminations use thermoplastic sleeving over bare conductors.

.5 Where cables are buried in cast concrete or masonry sleeve for entry and exit of cables.

.6 Do not splice cables.

3.4 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible.

.2 Terminate cables in accordance with Wire and Box Connectors - 0 - 1000 V Section.

.3 These cables are to be installed in concealed locations only. These concealed locations are considered to be stud walls and “drops” to stud walls, lighting fixtures, and ceiling mounted devices.

.4 These “drops” shall not be permitted to exceed 2.4 m (8'-0"). To limit these “drops” to lengths noted above provide additional branch wiring in conduit.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data for cabinets in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 MATERIALS

.1 Splitters must conform to CSA C22.2 No. 76 (latest edition).

.2 Junction and pull boxes must conform to CSA C22.2 No. 40 (latest edition)

2.2 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

.4 Splitter length must match arrangement of equipment unless indicated otherwise.

2.3 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

Part 3 Execution

3.1 SPLITTER INSTALLATION

.1 Install splitters and mount plumb, true and square to the building lines on 21 mm (3/4") painted plywood backboards.

3.2 JUNCTION AND PULL BOXES INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Install junction and pull boxes so as not to exceed 30 m (100') of conduit run between pull boxes and in conformance with the Electrical Safety Code.

3.3 IDENTIFICATION

.1 Provide equipment identification in accordance with General Electrical Requirements Section.

.2 Install size 2 identification labels indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Outlet boxes, conduit boxes, and fittings must conform to CSA C22.2 No. 18 (latest edition).

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm (4") square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 64 mm (3" x 2" x 2½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required. Iberville 1104 Series.

.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit **in utility rooms**, minimum size 102 mm x 57 mm x 38 mm (4" x 2¼" x 1½"). Iberville 1110 Series.

.3 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.

.4 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished tile walls.

2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

.1 Flush floor boxes where indicated shall be complete with the following features:

.1 Four (4) independent wiring compartments.

.2 Flexible activation cover.

.3 Fully adjustable.

.4 Sixteen (16) Kos 12.7 mm (½ ") – 32 mm (1 ¼ ").

.5 Stamped steel construction (concrete-tight).

.2 Manufacturers:

.1 Wiremold Cat# RFB4-DTB-2-2T-RAKM11- flush floor box complete with two duplex receptacle brackets, 2 dual RJ brackets, and recessed activation with carpet trim plate.

Approved alternates:

.1 Hubbell Cat. #LCFBSS complete with LCFB XX (colour by architect), flush cover and internal faceplate to suit devices noted on the drawings.

.2 Wellmark Electric Inc. Cat. #400B-1-YY-XX-CRL.

2.6 CONDUIT BOXES

.1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle **in areas (other than utility rooms) where surface conduit is used.**

2.7 FITTINGS- GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm (1- 1/4") and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm (1/4") of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.5 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.2 No.65-1956(R1965) Wire Connectors.

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as indicated.

.2 Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 10 AWG or less.

.3 Clamps or connectors for armoured cable, mineral insulated cable, and flexible conduit, as required.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

Part 1 General

1.1 Not Applicable.

Part 2 Products

2.1 MATERIALS

.1 Grounding equipment must conform to CSA C22.2 No 41 (latest edition).

2.2 EQUIPMENT

.1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe and electrically conductive metal gas piping.

.2 Rod electrodes: copper clad steel 19 mm (3/4") diameter by 3 m (10') long.

.3 Plate electrodes: galvanized steel, surface area 0.2 m^2, minimum 1.6 mm thick.

.4 Insulated grounding conductors: green with insulation type that matches specified phase conductors. Gauge shall be in conformance with the latest edition of the Electrical Safety Code to suit required installation conditions.

.5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

- .1 Grounding and bonding bushings.
- .2 Protective type clamps.
- .3 Bolted type conductor connectors.
- .4 Thermit welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. **Where EMT is used, run ground wire in conduit.**

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

.3 Protect exposed grounding conductors from mechanical injury.

.4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process inspectable wrought copper compression connectors to ANSI/IEEE 837.

.5 Make bonding connection to gas piping from electrical service ground at each location it enters a building, including multiple entries.

.6 Use mechanical connectors for grounding connections to equipment provided with lugs.

.7 Soldered joints not permitted.

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

.9 Install separate ground conductor to outdoor lighting standards.

.10 Ground pad mounted transformers as detailed on the drawings.

3.2 ELECTRODES

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter. This shall apply to the installation or replacement of building water service.

.2 Install water meter shunt.

.3 Make ground connections to continuously conductive metal gas piping system. This shall apply to installation or replacement of gas appliances, as well as installation or modification of a building gas piping system.

.4 Corrugated metal tubing shall not be used as a bonding means for the gas piping system.

.5 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.

.6 Install rod or plate electrodes and make grounding connections.

.7 Bond separate, multiple electrodes together.

.8 Use #2/0 copper conductors for connections to electrodes. Size in conformance with the Electrical Safety Code.

3.3 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Electrical Service equipment, electrically conductive underground water pipe, electrically conductive metal gas piping, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, and outdoor lighting.

3.4 COMMUNICATION SYSTEMS

.1 Install grounding connections for telephone, sound, fire alarm, computer network systems as follows:

.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

.2 Sound, fire alarm, computer network systems as indicated.

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Electrical General Requirements Section.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 APPLICATION

.1 Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.

.2 Where the structural engineer or architect documents have Ie*Sa(0.2)*Fa<3.5 seismic is not required on the electrical systems.

.3 Where the structural engineer or architect documents have Ie*Sa(0.2)*Fa≥3.5 seismic is required on the electrical systems.

.4 Seismic will always be required on fire protection systems when required by NFPA codes.

.5 Seismic will always be required on any “Disaster Relief Building.” For example, hospitals, police stations, ambulance building, etc.

.6 When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

1.2 SECTION INCLUDES

.1 Seismic Requirements for free standing equipment and other similar systems.

.2 Seismic Requirements for single rod hanger supports for conduit, and other similar systems.

.3 Seismic Requirements for trapeze type supports for bus tray, conduit, and other similar systems.

1.3 REFERENCES

.1 Building Officials and Code Administrators National Building Code (BOCA) (latest edition).

.2 Ontario Building Code (OBC), (latest edition).

1.4 QUALITY ASSURANCE

.1 The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of free standing electrical equipment, conduit, cable trays and other similar suspended systems and equipment as determined by seismic restraint designer.

.2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.

.3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

.4 Only companies experienced in performing the work of this section shall do the installation.

.5 All seismic restraint installations shall be independently reviewed by the Owner's representatives for compliance with project specifications.

1.5 SUBMITTALS

.1 Submit seismic force calculations according to forces chart located on structural engineer of record's drawings. Submit pre-approved restraint selections and installation details from acceptable manufacturer specified in this section or engineer approved equal.

.2 Restraint selection and installation details shall be pre-approved by a professionally licensed engineer with at least 5 years of experience in the design of seismic restraints.

.3 Submit manufacturer's product data on strut channels including, but not limited to, types, materials, finishes, gauge thickness, and hole patterns.

.4 Contractor to retain services of Professional Engineer, designated in local jurisdiction and submit stamped drawings. The same engineer shall provide periodic field review and final certification upon completion of the project.

The following companies are provided for information purposes:

.1 Tecoustics Limited - 1-888-714-9596

.2 Lampkin Structural Services – 613-830-6875

.3 Vibro Acoustics – 1-800-565-8401

.4 Tecoustics Vibration Control & Seismic Restraint – 905-681-6077

.5 Gerrits Engineering 705-737-3303

.5 All fees and associated costs for the engineering shall be the responsibility of this contractor.

1.6 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS

.1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.

.2 Design analysis shall include force calculations according to forces chart listed on the structural engineer of record's drawings and capacity of materials utilized for the connection of the equipment or system to the structure.

.3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.

.4 All seismic restraint devices shall be designed to accept without failure the calculated forces as pee the applicable Building Code.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.

.2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

1.8 WORK FURNISHED BUT NOT INSTALLED

.1 The materials and systems specified in this section shall be purchased by the electrical contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

.2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the electrical equipment.

1.9 COORDINATION

.1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.

.2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. switchboards, motor control centres, transformers, and other similar equipment).

1.10 DESCRIPTON OF SYSTEM

.1 It shall be understood that the requirements of this seismic restraint section are in addition to other requirements as specified elsewhere for the support and attachment of equipment and electrical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section.

.2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.

.3 All seismic snubber restraint assemblies shall meet the following minimum requirements:

.1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).

.2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.

.3 All snubbers are to include a maximum air gap of 0.25" (6 mm).

.4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.

.5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:

.1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.

.2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.

.3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

1.11 SYSTEM DESIGN

.1 Seismic restraint manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

.2 The contractor shall furnish, to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length, and width dimensions, and installed operating weights of the equipment to be restrained.

.3 All conduit etc. is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as “worst case” reaction loads for each restraint and/or anchor size.

.4 The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size or the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

1.12 ALTERNATE SYSTEMS

.1 Provisions of the General Conditions and Supplemental Conditions of the specifications shall govern the use of alternate systems to those specified.

.2 Manufacturers not listed as approved in “Part 2 Materials” of this section must secure approval to bid a minimum of ten (10) days prior to the project bid date.

.3 Uncertified internal equipment seismic restraint systems are disallowed for use on this project.

1.13 INSTALLATION

.1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer’s written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Cooper B-Line.

.2 Unistrut Building Systems.

.3 Kinetics Noise Control Inc.

.4 Mason Industries.

.5 Engineer approved equal.

2.2 SEISMIC BRACING COMPONENTS

.1 Steel strut and bracing components shall be utilized in combinations as required to meet designed load capacities.

.2 Fittings and accessories: Products shall be of the same manufacturer as strut and designed for use with that product.

2.3 BUILDING CODE REQUIREMENTS

.1 Seismic Zone Factors and coefficients shall be according to geographical area information table located on structural engineer of record's drawings.

2.4 SEISMIC SNUBBER TYPES

.1 GENERAL

(Isolator/Snubber Types contained herein are per ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, HVAC Applications, Seismic and Wind Restraint Design)

.2 Type J, Cable Restraints for Suspended Conduit and Trapeze

.1 Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for conduit, trapeze assemblies, and suspended equipment in all lateral directions.

.2 Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.

.3 Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is lesser.

.4 Seismic wire rope connections shall be made using overlap wire rope "U" clips or seismically rated tool-less wedge insert lock connectors.

.5 Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical "up" forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable straps. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.

.6 Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.

.7 Seismic cable shall be as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

.8 Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU, or KSCC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

.9 Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

.10 Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

.11 Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

.12 Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

Part 3 Execution

3.1 INSTALLATION

.1 All seismic restraint systems shall be installed in strict accordance with the manufacturer's seismic restraint guidelines manual and all certified submittal data.

.2 Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

.3 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration isolation system specified.

.4 Do not install any equipment, piping, duct, or conduit that makes connections with the building unless isolation is not specified.

.5 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

.6 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

.7 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

.8 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

.9 Provide reinforced clevis bolts where required.

.10 Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

.11 Do not brace a system to two independent structures such as a ceiling and wall.

.12 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

.13 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.

.14 Do not install any seismic restraint for equipment, cable trays or conduit that compromises isolation specified.

.15 Hold down clamps must be used to attach conduits and/or cables to all trapeze members before applying restraints.

.16 Conduit crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the conduit, equipment connections, or support connections. Conduit offsets, loops, anchors, and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.

.17 Coring is not permitted for the installation of concrete anchors. Use ground penetrating radar or equivalent method of embedment item detection to locate all embed items including reinforcing steel and electrical conduits. Concrete reinforcing steel and electrical conduits shall not be cut or damaged under any circumstances.

3.2 EXECUTION

.1 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.

.2 If mounting hole diameter exceeds bolt diameter by more than 0.125" (3 mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.

.3 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.

3.3 INSPECTION

.1 The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.

.2 Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.

.3 The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.4 CONDUIT

.1 Seismically restrain all electrical conduit. Use Type J Cable Restraints for all conduit supported by vibration isolation hanger assemblies. Brace all conduit to code requirements (IBC or TI-809-04) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

- .1 CAN/CSA C22.2 No.18-92, Outlet Boxes, Conduit Boxes, and Fittings.
- .2 CSA C22.2 No.45-M1981(R1992), Rigid Metal Conduit.
- .3 CSA C22.2 No.56-1977(R1977), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .4 CSA C22.2 No.83-M1985(R1992), Electrical Metallic Tubing.
- .5 CSA C22.2 No.211.2-M1984(R1992), Rigid PVC (Unplasticized) Conduit.
- .6 CAN/CSA C22.2 No.227.1, Nema TC-13, Flexible Nonmetallic Tubing.

Part 2 Products

2.1 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No.45, aluminum threaded.

.2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.

.3 Electrical metallic tubing (EMT) with couplings: to CSA C22.2 No.83.

.4 Rigid PVC conduit: to CSA C22.2 No.211.2.

.5 Flexible metal conduit: to CSA C22.2 No.56, aluminum and liquid-tight flexible metal.

.6 Flexible PVC conduit: to CAN/CSA C22.2 No.227.1 and Nema TC-13, Electrical nonmetallic tubing (ENT).

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 53 mm (2") and smaller. Two hole steel straps for conduits larger than 53 mm (2").

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1.5 m (5'-0") oc.

.4 Threaded rods, 6 mm (1/4") diameter, to support suspended channels.

2.3 CONDUIT FITTINGS

.1 EMT fittings shall be set screw style (zinc alloy).

.2 Flexible metal conduit fittings shall be screw-in type.

.3 Liquid type flexible metal conduit fittings shall be sealtite type.

.4 PVC fittings shall be PVC type complete with PVC adaptors at all boxes.

.5 Rigid conduit and mineral insulated conduit fittings shall be threaded type.

.6 Coating: same as conduit.

.7 Factory "ells" where 90° bends are required for 27 mm (1") and larger conduits.

.8 Where bushings are noted to be provided they must be “screwed” type fastened to a conduit connector. Push-fit or glued in place bushings will NOT be accepted.

2.4 FISH CORD

.1 Nylon twine.

Part 3 Execution

3.1 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conceal conduits except in mechanical/ electrical service rooms and in unfinished areas.

.3 Where devices are to be installed on existing walls in finished area, which cannot be “fished”, install feeds in a surface metal raceway equal to Wiremold V700 series. Coordinate surface installations with Consultant prior to rough-in, unless otherwise noted.

.4 Use electrical metallic tubing (EMT) for all branch circuits unless specified otherwise.

.5 Electrical nonmetallic tubing (ENT) may be used only for branch circuits in non-combustible buildings, in framed wall construction for residential suites, within block walls, and in precast or cast in place walls and floors. **Use of ENT for direct burial, plenum ceilings, or outdoor environments will not be accepted.**

.6 Use rigid aluminum threaded conduit where specified and up to 2.1 m (7'-0") above finish floor where exposed to mechanical injury.

.7 Use rigid PVC conduit underground and in kitchen areas.

.8 Use flexible metal conduit for connection to motors in dry areas, connection to recessed fixtures without a prewired outlet box, connection to surface or recessed fixtures, work in movable metal partitions.

.9 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations and for connections to kitchen equipment.

.10 Conduits terminating at electrical equipment in sprinklered areas are to be provided rain-tight insulated compression style connectors.

.11 **Minimum conduit size for branch circuits shall be 21 mm (3/4").** Single drops from ceiling mounted junction boxes down to a light switch or duplex receptacle may be reduced to 16 mm (½").

.12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.13 Mechanically bend steel conduit over 27 mm (1") diameter.

.14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.15 Install fish cord in empty conduits.

.16 Run 2- 27 mm (1") spare conduits up to accessible ceiling space from each flush panel. Terminate these conduits in 152 mm x 152 mm x 102 mm (6" x 6" x 4") junction boxes in ceiling space.

.17 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.18 Dry conduits out before installing wire.

.19 Do not install, store, or handle ENT in cold temperatures below -20°C(-4°F). Do not store ENT outside.

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m (5') clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

.7 Do not fasten surface conduit to roof deck. Provide standoffs or supports as manufactured by Caddy or use Unistrut trapeze fastened to structure.

3.3 CONCEALED CONDUITS

.1 Do not install horizontal runs in masonry walls.

.2 Do not install conduits in terrazzo or concrete toppings.

3.4 CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Locate to suit reinforcing steel. Install in centre one third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

.5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.

.6 Encase conduits completely in concrete with minimum 27 mm (1") concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Run conduits 27 mm (1") and larger 300 mm (12") below slab (measured from top of slab to bottom of conduit) and encased in 78 mm (3") sand envelope.

3.6 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

END OF SECTION

Part 1 General

1.1 GENERAL PROVISIONS

.1 Conform to the General Provisions of Division 1 and Electrical General Requirements Section.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 MATERIALS

.1 Rigid PVC ducts must conform to CSA C22.2 No. 211.0, 211.1 and 211.2 (latest edition).

.2 Ducts and/or cables must be excavated, bedded, reinforced, encased and backfilled as per details on the drawings.

2.2 DUCT

.1 Ducts indicated for encasement in concrete must be type DB-2. Ipex “Super Duct” or approved equal.

.2 Ducts indicated for direct burial must be type SCEPTER. Ipex “Scepter” rigid PVC duct or approved equal.

2.3 DUCT FITTINGS

.1 Fittings required to provide a complete continuous duct bank installation shall include but not be limited to, couplings, bell end fitting, caps, adapters, base and intermediate spacers.

.2 Small or large angle couplings will be required where noted on the drawings.

.3 Expansion joints are to be provided when running ducts in concrete across expansion joints and where exposed on roofs or exterior of buildings.

Part 3 Execution

3.1 BASIC INSTALLATION

.1 Excavate trench along route as indicated and at a depth to suit cables and/or ducts as detailed.

.2 If required, trench is to be pumped to maintain excavation free of water.

.3 Import granular fill and place in bottom of trench. Compact to provide a firm level base.

.4 Quantity and arrangement of ducts must be provided according to drawing details.

.5 When ducts terminate at buildings or precast bases provide bell end fittings.

.6 When ducts enter buildings below grade they shall be sealed inside and out at the building foundation and service entrance equipment with a suitable duct sealing compound to prevent the entrance of moisture or gases.

.7 When terminating a duct bank for future extension terminate each duct with a coupling. If ducts are encased in concrete set coupling flush with end of concrete.

.8 Attach ducts to spacers using non-metallic materials.

.9 Provide concrete as detailed. Pour concrete down sides of duct bank to ensure spaces around and under ducts are filled first.

.10 Concrete must obtain 50% of its specified strength prior to backfilling.

.11 Backfilling must be imported granular 'A' material.

.12 Backfill must be placed as 150 mm (6") compacted lifts.

.13 Excess excavated material must be removed from site by this contractor.

.14 Ensure ducts indicated to be installed along a curb line are installed at least 600 mm (24") from that curb line.

3.2 DIRECT BURIAL OF DUCTS

.1 After sand bed specified is in place, lay ducts maintaining 75 mm (3") clearance from each side of trench to nearest duct. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset ducts 150 mm (6") for each 60 m (200') run, maintaining minimum duct separation and bending radius requirements.

.3 Underground cable splices not acceptable.

.4 Duct separation:

.1 Provide separation of ducts in conformance with the details in the Electrical Safety Code.

3.3 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables are properly terminated, seal ends of cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.4 FIELD QUALITY CONTROL

.1 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.2 Check phase rotation and identify each phase conductor of each feeder.

.3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 mega ohms.

.4 Pre-acceptance tests.

.1 After installing cable but before terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.5 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.

.6 Remove and replace entire length of cable if cable fails to meet any of test criteria.

.7 The Consultant requires a minimum of 48 hours notice to inspect at his discretion the following; duct bank excavation, bedding and duct placement, pouring and/or placement of duct bank encasement.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The studies must be submitted to the Consultant prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Consultant may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

.2 The studies shall include all portions of the electrical distribution system from the normal power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system, **as well as mechanical unit equipment.** Normal system connections and those, which result in maximum fault conditions, shall be adequately covered in the study.

.3 The firm should be currently involved in high- and low-voltage power system evaluation. The study must be performed, stamped and signed by a registered professional engineer in the Province of Ontario. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Consultant for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.

.4 The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.

1.2 DATA COLLECTION FOR THE STUDY

.1 The Contractor shall provide the required data for preparation of the studies. The Consultant performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract.

.2 The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.

.3 Data collected for the study, including correspondence with local utility, shall be included with study report.

Part 2 Products

2.1 SHORT CIRCUIT AND PROTECTIVE DEVICE EVALUATION AND COORDINATION STUDY

.1 The short-circuit study shall be performed with the aid of a digital computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.

.2 In the short-circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.

.3 In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.

.4 Include on the curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. In addition, include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.

Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.

.5 Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.

.6 Include complete fault calculations as specified herein based on contract documents.

.7 Submit qualifications of individual(s) who will perform the work for approval prior to commencement of the studies. Provide studies in conjunction with equipment submittals to verify equipment ratings required. Submit the study to Consultant for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

.8 Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.

.9 Include fault contribution of all motors in the study. Notify the Consultant in writing of circuit protective devices not properly rated for fault conditions.

.10 When emergency generator is provided, include phase and ground coordination of the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Contractor shall obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.

.11 Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.

.12 For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.

.13 Evaluate proper rating of applicable mechanical unit equipment based on available fault at unit connection. Mechanical unit equipment in study shall include packaged assemblies identified as, but not limited to, AHUs, MUAs, DOAS, Chillers, and Cooling Towers.

2.2 ARC FLASH HAZARD ANALYSIS

.1 The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D and CSA Z462-(latest edition).

.2 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

.3 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

.4 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

.5 The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

.6 Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

.7 The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

.8 Arc Flash computation shall include both line and load side of main breaker calculations, where necessary.

.9 Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-latest edition section B.1.2.

.10 Arc Flash computation shall include arc flash current magnitude at each circuit breaker 1200A or higher (ARMS capable) to allow the Arc Flash Reduction Maintenance System pickups to be set based on multiples of the per unit secondary arc current monitored by the trip unit.

2.3 STUDY REPORT

.1 The results of the power system study shall be summarized in a final report. Submit report in accordance with Electrical General Requirements Section as a shop drawing.

.2 The report shall include the following sections:

.1 Descriptions, purpose, basis, and scope of the study.

.2 Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.

.3 Tabulations of mechanical unit equipment ratings as identified on equipment shop drawings versus calculated short-circuit, and commentary regarding same. Short-circuit calculations for mechanical equipment shall be based on unit MCA with conductor sizes as identified on electrical design drawings and not based on equipment MOCP.

.4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

.5 Fault current calculations including a definition of terms and guide for interpretation of computer printout.

.6 Incident energy and flash protection boundary calculations

.1 Arcing fault magnitude

.2 Device clearing time

.3 Duration of arc

.4 Arc flash boundary

.5 Working distance

.6 Incident energy

.7 Hazard Risk Category

.8 Recommendations for arc flash energy reduction

.9 Recommendations for Personal Protection Equipment (PPE) level.

Part 3 Execution

3.1 POWER COMPANY APPROVAL

.1 Copies of the final report must be submitted to the power company for their review and approval. Approved copies of the report shall be submitted to the Consultant.

3.2 FIELD SETTINGS

.1 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, and protective device coordination study.

.2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

.3 At the completion of the project, configure settings and install equipment labels. On company letterhead, the contractor is to prepare a certification letter indicating at minimum:

.1 Project
.2 Date
.3 Device designation
.4 Certification of correct settings
.5 Certification of correct device labels
.6 Certification of arc flash hazard equipment labels
.7 Digital image of each breaker indicating final settings and placement of labels

3.3 ARC FLASH WARNING LABELS

.1 The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

.2 The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:

.1 Location designation
.2 Nominal voltage
.3 Flash protection boundary
.4 Hazard risk category
.5 Incident energy
.6 Working distance
.7 Personal Protection Equipment (PPE) level
.8 Engineering report number, revision number and issue date.

.3 Labels shall be machine printed, with no field markings.

.4 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

.1 For each 600, 480 and applicable 208 volt panelboards, one arc flash label shall be provided.

.2 For each motor control center, one arc flash label shall be provided.

.3 For each low voltage switchboard, one arc flash label shall be provided.

.4 For each switchgear, one flash label shall be provided.

.5 For medium voltage switches one arc flash label shall be provided

.5 Labels shall be field installed by the firm providing the Arc Flashing Hazard Analysis.

3.4 SERIES RATING LABELS

.1 Provide lamacoid labels where recommended by study. **Labels for series rating with panelboards or equipment shall be indicated on feeder breaker as "SERIES RATING BREAKER" and at the panelboard or equipment as "SERIES RATING EQUIPMENT". Refer to section 26 24 16.**

3.5 ACCEPTABLE TESTING FIRMS

.1 MVA Engineering (519) 668-4698

.2 GT Woods (905) 272-1696

.3 Brosz & Associates (905) 472-6660

.4 K-Tek Electro-services Ltd. (905) 640-0660 ext. 228

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS

.1 Submit shop drawings for each system in Conformance with The Electrical General Requirements Section.

1.2 PRODUCT/MAINTENANCE DATA

.1 Submit product/maintenance data for each system for inclusion in maintenance manual conforming to The General Electrical Requirements Section.

1.3 SCOPE

.1 The scope of this Section will include the following systems.

- .1 Surface mounted raceway.
- .2 Hand dryers.
- .3 Cable management hangers.
- .4 Cable management system.
- .5 Auxiliary systems rough-in.
- .6 Security and access control rough-in.
- .7 Telecommunication network system rough-in.
- .8 Miscellaneous clocks.
- .9 Destratification fans and controls.
- .10 Classroom control panels.
- .11 Public address system rough-in.
- .12 Digital time switch.
- .13 Photocontrol switch.
- .14 Line voltage power packs and low voltage occupancy sensors.

Part 2 Products

2.1 SURFACE MOUNTED RACEWAY

.1 The two compartment surface raceway shall be complete with the following features:

- .1 Surface non-metallic raceway is to be utilized in dry interior locations only.
- .2 The surface non-metallic raceway system specified herein for branch circuit wiring and/or data network, voice, video and other low-voltage wiring shall be the 5400 System as manufactured by the Wiremold Company.
- .3 The raceway and all system components must be UL Listed, and exhibit non-flammable self-extinguishing characteristics tested to comparable specifications of UL94V-0. The raceway base and cover shall be manufactured by rigid compound, available in ivory or white colours (Architect Selection).

.4 The raceway shall be a two-piece design with a base and a snap-on cover. Total width shall be 133 mm (5¼") by 44.5 mm (1¾") deep with an approximate thickness of 2.4 mm (1/12"). The base and cover shall be available in 2.4 m (8') lengths. The raceway shall be available with two multiple wiring channels formed by integral barriers in the base.

.5 The cover shall span the entire width of the base concealing all of the wiring channels.

.6 A full complement of fittings must be available including, but not limited to flat, internal and external elbows, tees entrance fittings, cover clips and end caps. They shall be manufactured of a rigid PVC compound. The fittings shall have a matte texture, in ivory or white colours to match the base and cover. They shall overlap the cover and base to hide uneven cuts. All fittings shall be supplied with a base where applicable to eliminate mitring. A transition fitting shall be available to adapt to other Wiremold series raceways.

.7 Device brackets shall be available for mounting standard devices in-line with the raceway. Faceplates shall match and fit flush in the device plate. They shall be manufactured of rigid PVC compound. They shall be ivory or white colours to match raceway base cover (Architect selection). Contractor is to provide devices as noted.

.8 The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP (including Category 5e and 6), STP (150 ohm) Fibre Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. The electrical contractor is to provide adapter plates for faceplates to be provided by the voice/data sub-contractor. The recommended plate is a Deco adapter 3-port plate style, confirm with voice/data sub-contractor.

.2 Acceptable alternate manufacturers include:

.1 Hubbell Base Trak

.2 Panduit Pan-Way

2.2 HAND DRYERS

.1 Hand dryers where noted on the drawings are to be supplied and installed by this Division with the following features:

.1 Surface mounting.

.2 Fixed nozzle.

.3 White finish with automatic activation.

Final finish selection by owner/architect.

.4 Rating of 1800 W at 120 V.

.5 Cat. #NOVA 5-0212

.1 World Dryer Cat. #XA5-2-974.

2.3 CABLE MANAGEMENT HANGERS

.1 Hangers where noted are to be complete with the following features:

.1 Approximately 150 mm (6") high by 80 mm (3¼") protrusion.

.2 Constructed from 5 mm (3/16") x 20 mm (3/4") flat steel bar and formed to resemble the letter “G”.

.3 Seven 6 mm (1/4") diameter mounting holes are to be provided around the hanger perimeter.

.4 Matte black finish.

.5 Suitable for wall or suspended mounting.

.6 Acceptable Manufacturers:

.1 EMF Cat. #H-533-S

.7 Manufacturer Contact:

Electron Metal Fabricators Inc.
2160 Dagenais Boulevard West
Laval, Quebec
H7L 5X9
Phone: 450-625-8064 or 1-800-267-8064
Fax: 450-625-8004

.8 Acceptable Alternate:

Wiremold Cat. #GH030406
Mono System Cat. # The Hook H-433
Cablofil Cat. #CSGH-3-4-6
Eaton Cat. #B-Line

.2 As an alternate to the hanger system detailed the contractor may

a) Use as an equal one run of 50 mm (2") x 150 mm (6") wire mesh cable management system equal to Cablofil Cat. #CF 54/150 EZ complete with Cat. #FAS L 150 universal wall bracket where noted to be wall mounted and Cat. # FAS C 200 where noted to be hung. The hangers are to be installed at intervals as recommended by the manufacturer but no greater than 2.4 m (8'-0") on centre.

2.4 CABLE MANAGEMENT SYSTEM

.1 The system where noted shall be a continuous, rigid, welded steel wire mesh cable management system with the following features:

.1 Permits continuous ventilation of cable and maximum dissipation of heat.

.2 Continuous safety edge T-welded wire lip.

.3 Welded at all intersections.

.4 Straight sections 4" x 12" (100 mm x 300 mm) in configurations noted on the drawings.

.5 Constructed of carbon steel wire, ASTM A 510, grade 1008. Wire welded, bent, and surface treated after manufacture.

.6 Post fabrication finish of electro-plated zinc galvanizing: ASTM B 633, Type III, SC-1.

.7 Fittings: Field fabricated in accordance with manufacturer’s instructions from straight sections.

.2 The support system shall be Cablofil FAS CH hanger.

.3 The necessary hardware, including splice connectors and support components furnished by manufacturer.

.4 The product shall be Cablofil Cat. #CF105/300EZ complete with Cat. #FAS P300 CH at intervals as recommended by the manufacturer.

.5 The manufacturer shall be:

.1 Cablofil Inc.
Local representation by:
Cablofil
533 Galway Drive
Burlington, Ontario
L7L 2S6
Ph: 905-681-5380
Fax: 905-681-2206

.6 Approved equals:

.1 Eaton B-Line FT4x12x10 complete with 12 CTR HGR
Intralec Electrical Products Ltd.
1200 Cardiff Blvd.
Mississauga, Ontario
L5S 1P6
Phone: 905-670-0970

2.5 AUXILIARY SYSTEMS ROUGH-IN

.1 Outlets where noted shall be single gang boxes unless specified otherwise.

.2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

.3 Coordinate final outlet locations, quantities, etc. with respective system vendor and owner's representative.

.4 Auxiliary systems installation such as CATV, A/V, etc., may be provided by owner's approved vendor as part of cash allowance. Rough-ins only for system devices shall be included in electrical bid price.

2.6 SECURITY AND ACCESS CONTROL ROUGH-IN

.1 Provide conduit from device and outlet locations to cable management systems as noted on drawings.

.2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

.3 Provide grounding of equipment as noted on drawings.

.4 Security and access control systems installation shall be by Owner's approved vendor as part of separate tender.

2.7 TELECOMMUNICATION NETWORK SYSTEM ROUGH-IN

.1 Outlets where noted shall be single gang flush mounted in wall or surface raceways.

.2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

.3 Provide a #6 insulated green ground conductor from main service ground to voice equipment backboard located on drawings.

.4 Telecommunication Network installation shall be by Owner's approved vendor as part of separate tender.

2.8 MISCELLANEOUS CLOCKS

.1 Room and/or office clocks shall be surface mounted 300 mm (12") round style, battery operated. Finish to suit Architect.

.2 Library and general purpose room clocks shall be surface mounted 375 mm (15") round style, battery operated. General purpose room clocks must be provided with wire guard. Finish to suit Architect.

.3 Manufacturers shall be as follows:

.1 300 mm (12"):
Edwards Cat. #2941-2B
Simplex Cat. #BAT Series
American Time Cat. #E56BASD304

.2 355 mm (14")
La Crosse Technology Cat.#WT-3143A

.3 375 mm (15"):
Edwards Cat. #2942-2B
Simplex Cat. # BAT Series
American Time Cat. # E66BADD304

.4 Wireguard for 375 mm (15") clock:
Edwards Cat. #2091A
Simplex Cat. # BAT Series
American Time Cat. #G2366

2.9 DESTRATIFICATION FANS AND CONTROLS

.1 General purpose fans in the gym to be provided with the following features:

.1 Metal construction.

.2 Baked white enamel.

.3 Down-blowing single direction.

.4 1400 mm (56") diameter blade combination.

.5 Minimum 400 mm (16") suspension with ball aligner and canopy.

.6 Suitable for 120V/1/60Hz operation.

.7 Provided with wire cage when installed in general purpose rooms.

.8 Manufacturer:

.1 Banvil Cat. #60F9-10 (FG60C where noted).

.2 Single fan variable speed controller shall be Banvil Cat. #100P c/w colour and coverplate to suit this specification.

.3 Multiple fan variable speed controller shall be Banvil Cat. [#105F (up to 4 fans), 150F (up to 8 fans), or 200F (up to 12 fans)] c/w colour and coverplate to suit this specification.

.4 Approved equal:

.1 Pleasantaire

.5 Decorative fans as indicated are to be provided with the following features:

.1 Metal construction.

.2 Blade, downrod and motor finish as directed by Architect.

.3 Down-blowing single direction.

.4 1300 (52") diameter blade combination.

.5 Minimum 400 mm (16") suspension with ball aligner and canopy.

.6 Suitable for 120V/1/60 Hz operation.

.7 Manufacturer: Big Ass Fans Cat. #K3127-A2-XX-XX-XX-03-C complete with multi-button wall mounted controller.

2.10 CLASSROOM CONTROL PANELS

.1 Provide surface mounted Classroom Hub Control Panels as detailed on the drawings.

.2 Modular control panels shall be constructed of structurally sound 6063 T5 alloy satin anodized aluminum frame .08mm thick with high pressure plastic laminate faced panels of lightweight particle core and 0.5mm thick plastic laminate backing sheet. Plastic laminate colour as selected by the Architect from Arborite or Formica, furniture finish, from manufacturer's standard colour range. Complete assembly to meet flame spread ratings in areas used.

.3 Units to be complete with backboxes fabricated from heavy gauge satin coat steel with suitable barriers and continuous knockouts. Satin anodized faceplates shall be pre-punched to accept detailed components.

.4 All panels shall be vandal resistant and removable with special tools for service access.

.5 Fabricate units in accordance with reviewed shop drawings with extruded aluminum frames and solid plastic laminated face panels.

.6 Panels to be removable from aluminum frames with rounded profile edging.

.7 Front panels to have colour finish as selected by the Architect.

.8 Panels to have all openings, mounting hardware, etc. for services as required for installation of mechanical and electrical services.

.9 Units to be full height from 200 mm off floor to underside of ceiling panels. Standard unit dimensions are 16" in width, 4" deep.

.10 Acceptable Manufacturer (basis of design):

.1 Swift Path Solutions.

.11 Acceptable Alternates (no other alternates accepted):

.1 Control Hub Solutions Inc.

.2 Olympic Tool & Die Inc.

2.11 PUBLIC ADDRESS SYSTEM ROUGH-IN

.1 Provide conduit from device and outlet locations to cable management systems as noted on drawings.

.2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

.3 Provide grounding of equipment as noted on drawings.

.4 Public address system installation shall be by Owner's approved vendor as part of separate tender.

2.12 DIGITAL TIME SWITCH

.1 Supply and install a digital time switch with 40 Amp SPST contacts.

.2 Unit shall be capable of 20 set points.

.3 Unit shall repeat the same schedule each day.

.4 Unit shall have automatic Daylight Savings Time and Leap Year compensation.

.5 Unit shall program in AM/PM format.

.6 Unit shall have LCD display.

.7 Unit shall have permanent schedule retention.

.8 Unit real time clock shall be retained by super capacitator for 100 hours in a power failure.

.9 Unit shall be capable of manual override ON and OFF either to the next scheduled event or permanently.

.10 Unit shall have a NEMA 3R indoor/outdoor plastic enclosure.

.11 Unit shall have Load Status indication.

.12 Unit shall have Power Failure indication.

.13 Acceptable Manufacturer:

Tork Cat. #EW/EWZ Series

Use EW for control of indoor devices and EWZ for control of outdoor devices.

2.13 PHOTOCONTROL SWITCH

.1 Supply and install photo control with rating of;

.1 (1000, 1800, 2000) Watts

.2 (8.33, 14, 16.6) amperes tungsten at 120Volts

.3 50 to 60 Hz. AC

.2 Sealed cadmium sulphide photocell operates in temperature range of:

.1 -34^{0}C. (-30^{0}F) to 60^{0}C. (140^{0}F)

.3 Lights switching on/off:

.1 On at (1.5, 2, 3) footcandles.

.2 Off at (4.5, 10) footcandles.

.4 Diecast aluminum enclosure, gasketted for maximum weatherproofing.

.5 Thermal inertia gives minimum time delay of fifteen (15) seconds to prevent false or nuisance switching due to light from vehicles, lightning etc.

.6 Control to have standard threaded pipe nipple.

.7 Control to have manually adjustable lever slide.

.8 Acceptable manufacturers:

.1 Paragon Cat. #CW201-00 Series.

.2 Tork Cat. #2101 Series.

2.14 LINE VOLTAGE POWER PACKS AND LOW VOLTAGE OCCUPANCY SENSORS

.1 Line voltage power packs and occupancy sensors shall be one manufacturer throughout the project.

.2 Line Voltage Power packs shall be provided to match the room lighting load, control requirements, and lighting voltage. Power packs shall have the following features:

.1 Mount to standard junction box.

.2 Simple replacement. It shall be capable to replace the unit without requiring any configuration or set-up.

.3 Plenum rated

.4 120VAC or 347V, 60HZ operation.

.5 Acceptable materials:

.1 Sensorswitch Cat. #PP20 Series

.2 Legrand Cat. #BZ-250 Series

.3 Greengate Cat. #SP15 Series

.3 Low voltage / analog occupancy sensors shall be complete with the following features:

.1 Coverage pattern to suit room ceiling height.

.2 Suitable to detect minor and medium motion patterns within rooms less than 2000 sq. ft.

.3 Mount to standard junction box.

.4 Simple replacement. It shall be capable to replace the unit without requiring any configuration or set-up.

.5 Relays shall not be integrated within the occupancy sensor. Relays shall be provided within separate power pack.

.6 Acceptable materials

.1 Sensorswitch Cat. #CM-PDT Series

.2 Legrand Cat. #CI-205

.3 Greengate Cat. #OAC-DT-2000

Part 3 Execution

3.1 SURFACE MOUNTED RACEWAY

.1 Raceway is to be supplied and installed complete with all necessary fittings, hardware and device brackets for configuration as noted in the drawings for a complete functional installation.

.2 Install conduit system, wiring and devices as indicated.

.3 Ensure raceway is installed as per manufacturer recommendations.

.4 Where the raceway ends at a wall install end cap.

3.2 HAND DRYERS

.1 Install and connect hand dryers in conformance with manufacturer's recommendations.

.2 Hand dryers are to be mounted at a height to suit age of expected users. Unless otherwise noted confirm height with manufacturer, owner, Architect, and/or consultant prior to rough-in.

.3 Once installed this contractor is to caulk the joint between dryer and wall surface with a bead of clear silicone.

3.3 CABLE MANAGEMENT HANGERS

.1 Install hangers as per details in configuration noted.

.2 Prior to installation co-ordinate location with other services within the ceiling space.

.3 Co-ordinate with noted sub-contractors to install cables noted to be utilizing these hangers. Cables are to be installed such that the maximum sag between hangers does not exceed 25 mm (1"). This electrical contractor is to coordinate.

.4 Attaching cable to any T-bar support rods is not acceptable.

3.4 CABLE MANAGEMENT SYSTEM

.1 Install cable management system at locations indicated on the drawings and in accordance with manufacturer's instructions.

.2 Support system every 2.4 m (8'-0") unless system is used within a telecommunication room. In that situation support every 1.5 m (5'-0").

.3 Cut wires in accordance with manufacturer's instructions.

.4 Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer. Cut using side action bolt cutters (Cablofil Cat. #Coupfil).

.5 Cut each wire with 1 clean cut to eliminate grinding or touch-up.

.6 Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

.7 Suspend from structure or intermediate Unistrut channel spanning across the corridor where access to structure is not available due to the concentration of mechanical ductwork and/or piping.

.8 Ground cable tray with continuous ground per O.E.S.C. and manufacturer instructions. Test to ensure minimum 5 ohms resistance.

.9 Locate cable management system minimum 9" from EMI sources including but not limited to fluorescent lights, transformers, motors, and power cables.

3.5 AUXILIARY SYSTEMS ROUGH-IN

.1 Provide backboard for each system use as noted complete with ground buss connection as specified.

.2 Outlets are to be installed complete with minimum 21 mm (3/4") conduit to accessible ceiling space or as otherwise detailed.

.3 Conduits terminated into ceiling spaces must be within 3 m (10') of zone conduits when noted.

.4 Provide insulated bushings on all conduits terminated in ceiling space.

.5 Ensure specified zone or riser conduits are installed back to equipment backboard.

3.6 SECURITY AND ACCESS CONTROL ROUGH-IN

.1 Outlets are to be provided for devices with conduit as detailed on drawings.

.2 Conduits terminated into ceiling spaces must be within 1m of cable management of tray.

3.7 TELECOMMUNICATION NETWORK SYSTEM ROUGH-IN

.1 Install incoming service ducts and terminate as noted.

.2 Provide backboard as noted complete with ground connection to main service ground.

.3 Conduits terminated into ceiling spaces must be within 3 m (10') of zone conduits (if applicable).

.4 Ensure specified zone conduits are installed back to service backboard.

.5 Outlets are to be installed complete with 25 mm (1") conduit to corridor ceiling space or nearest zone conduit (if applicable).

.6 Provide insulated bushings on all conduits terminated in ceiling space.

.7 A 25 mm (1") conduit is to be installed from elevator machine room to voice service backboard.

.8 Refer to Telecommunication Network Installations Section for additional requirements.

3.8 MISCELLANEOUS CLOCKS

.1 Ensure clocks are installed where noted complete with batteries and all necessary mounting hardware.

.2 Set clocks to proper time of day and ensure all are operational at the time of final inspection.

3.9 DESTRATIFICATION FANS AND CONTROLS

.1 Ensure fans and controls are installed in conformance with manufacturer recommendations.

.2 Where noted install wireguards to be level. Fasten wireguards to structure NOT roof deck. Provide intermediate Unistrut supports to suit.

.3 Demonstrate fan operation at the time of final inspection.

.4 Contractor is to remove manufacturer's label prior to installation.

3.10 CLASSROOM CONTROL PANELS

.1 Electrical trade to supply and install units in accordance with manufacturers' recommendations and reviewed shop drawings complete with all frames, cut outs, face panels, etc., to provide a complete installation.

.2 It is the electrical trade's responsibility to coordinate complete installation of all mechanical, electrical and miscellaneous services in all control panels. Components within control panels will vary from room to room.

3.11 PUBLIC ADDRESS SYSTEM ROUGH-IN

.1 Conduits terminated into ceiling spaces must be within 1m (10') of cable management tray.

.2 Outlets are to be installed complete with 25 mm (1") conduit to corridor ceiling space or nearest cable management tray.

.3 Provide insulated bushings on all conduits terminated in ceiling space.

.4 Electrical contractor shall obtain speaker back boxes from School Board vender for installation into ceiling tiles, block walls, etc.

3.12 DIGITAL TIME SWITCH

.1 Install electromechanical lighting controls as indicated and in accordance with manufacturer's instructions.

.2 Coordinate with owner's representative and install 'trippers' to suit.

3.13 PHOTOCONTROL SWITCH

.1 Turns photo-initiated controls on at dusk.

.2 Turns lights on at dusk and off at dawn.

.3 Install photoelectric controls as indicated and in accordance with manufacturer's instructions on suitable weatherproof junction box.

3.14 LINE VOLTAGE POWER PACKS AND LOW VOLTAGE OCCUPANCY SENSORS

.1 Install power packs in accessible maintenance areas.

.2 Provide access doors if power packs are installed above drywall ceilings.

.3 Install sensors in gym where noted on plan at mid height of wall.

.4 Sensors installed in areas of high abuse shall be complete with wire guards.

.5 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per the manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.

.6 It is the contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the facility, to verify placement to sensors and installation criteria.

.7 The contractor shall also provide the on-site training necessary to familiarize the owner's personnel with the operation, use, adjustment and problem solving diagnosis of the occupancy sensing devices systems.

.8 Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control. Submit commissioning report with closeout documents.

.9 **All lighting controls shall be provided with functional testing and documentation conforming to Ashrae 90.1, latest adoption. This cost shall be included in the Tender Price.**

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Heaters must conform to CSA 22.2 No.46 (latest edition).

1.2 PRODUCT DATA

.1 Submit product data in accordance with the Electrical General Requirements Section.

.2 Product data to include:

- .1 Suspension of heating element.
- .2 Physical size.
- .3 Thermostat control if integral.
- .4 Finish.
- .5 kW rating, voltage, phase.
- .6 Cabinet thickness.
- .7 Cabinet surface temperature.
- .8 Mounting methods.
- .9 Auxiliary controls.
- .10 Replacement data for motor element, thermostat, and switch.

1.3 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for all heating system components for incorporation into manual as specified in the Electrical General Requirements Section.

Part 2 Products

2.1 BASEBOARD CONVECTORS

.1 Heaters shall be standard wattage density with connection box at one end. Element through-type fitted with aluminum convector vanes and resistor wire enclosed in mineral insulation in copper coated steel sheath.

.2 Element locked to cabinet and supported at additional points throughout length to allow for linear expansion with non-metallic supports.

.3 Cabinets shall be bottom inlet/outlet front panel 1.6 mm (3/32") thick, finished in baked enamel, (colour to suit architect). Integral air diffusion reflector with wireway at bottom.

.4 Blank cabinet sections where specified shall be complete with wireway in all sections including splice plates, to match heater cabinets in all respects for continuous baseboard effect as indicated.

.5 Controls shall be (as indicated) either wall mounted remote thermostats or integral 2 pole thermostats to control load of heater specified.

2.2 UNIT HEATERS

.1 Unit heater shall be horizontal discharge complete with adjustable louvers finished to match cabinet.

.2 Fan type unit heaters must be provided with built-in high-heat limit protection.

.3 Fan motor must be permanently lubricated ball bearing type with resilient mount. Built-in fan motor thermal overload protection.

.4 Hangers shall be as indicated on drawings.

.5 Elements shall be mineral insulated copper coated steel sheath with aluminum brazed fins.

.6 Cabinet shall be steel fitted with brackets for rod or wall mounting. Phosphatized and finished with baked enamel finish to suit architect.

.7 Controls shall be (as indicated) either wall mounted remote thermostats or integral 2 pole thermostats to control load of heater specified. Integral magnetic contactors (if specified) are to be provided to suit load.

.8 For the purposes of bidding, electrical trade shall include but not be limited to provision of a junction box to connect equipment wiring tail, provision of suitable disconnecting means, and flexible connection directly to equipment.

2.3 CABINET CONVECTOR HEATERS

.1 Wall mounted cabinet shall be front inlet/front outlet 1.6 mm (3/32") thick front steel panel. Phosphatized and finished with baked enamel. Finish colour to suit architect. Pre-drilled back for securing to wall.

.2 Elements shall be mineral insulated with copper sheath and pressed-on fins, secured and free-floating for expansion.

.3 Controls shall be (as indicated) either wall mounted remote thermostats or integral 2 pole thermostats to control load of heater specified.

2.4 FORCED AIR WALL HEATERS

.1 Forced air wall heaters, wall or ceiling mounted as noted complete with T-bar mounting frame. Heater shall be commercial type as follows:

.1 Enclosure:

.1 Steel: 18 gauge.

.2 Knockouts for 19 mm (3/4") diameter conduit left, right, bottom and rear.

.3 Grill and frame finished to suit architect.

.2 Elements and Fan:

.1 Mineral insulated.

.2 Motor: totally enclosed, shaded pole, impedance protected motor.

.2 Controls:

.1 Built-in tamperproof controls. 'On-Off-Fan Only' selector switch and temperature control knob.

2.5 THERMOSTATS

.1 Line voltage thermostats in finished areas as indicated shall be complete with the following features:

.1 Full load rating of maximum 18 A at 208 V

.2 Temperature range: 10ºC to 27ºC (50ºF to 80.6ºF)

.3 Temperature range shall be marked on face of thermostat in 5 degree increments.

2.6 APPROVED MANUFACTURERS

.1 Approved manufacturers shall be:

.1 Ouellet

.2 Stelpro

.3 Westcan

Part 3 Execution

3.1 INSTALLATION

.1 Install baseboard convector heaters, blank sections, and controls. When wireway is used, remove knock-outs and insert insulating bushing between each unit. Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.

.2 Suspend unit heaters from ceiling or mount on wall as indicated. Provide local disconnecting means.

.3 Install cabinet convectors as indicated.

.4 Install force flow heaters as indicated.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Electrical General Requirements Section.

.2 Ensure that heaters and controls operate correctly.

.3 On fan powered units:

.1 Test cut-out protection when air movement is obstructed.

.2 Test fan delay switch to assure dissipation of heat after element shut down.

.3 Test unit cut-off when fan motor overload protection has operated.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Dry type transformers must conform to CSA C22.2 No.47 and C9 (latest edition).

.2 **Dry type transformers must conform to CSA C802 (latest edition).**

.3 Dry type transformers must be in accordance with Ontario Green Energy Act 2018 (NRCan 2018) DOE 2016.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 TRANSFORMERS

.1 Transformers to be of one manufacturer throughout project.

.2 Ratings and characteristics shall be as indicated on riser diagrams.

.3 Aluminum winding.

.4 Transformers are to be ventilated dry type style with 4-2½% taps (2 F.C.B.N. and 2 F.C.A.N.)

.5 Maximum permissible sound levels shall be as follows:

Transformer Rating (KVA)	Sound Level (dBA)
≤50	45
51 to 150	50
151 to 300	55
301 to 500	60

.6 All transformers with a K factor of 4 or above must be electro-static shielded.

.7 Transformers with a K-factor of 4 or above must include a secondary neutral bus that is sized at twice the rated secondary phase current.

.8 Transformer enclosure shall be EEMAC/NEMA 3R ventilated complete with removable front panel.

.9 Provide vibration isolators equal to Korfund R series, Mason ND-B, or approved equal. "Colour" of vibration isolators shall be based on weight of transformers.

Transformer Weight (lbs)	Approximate Rating	Colour (Korfund)
540	15 – 75 kVA	Blue (RD2)
680	112.5 kVA	Black (RD2)
960	150 kVA	Red (RD2)
1,520	300 kVA	Green (RD2)
2,200	500 kVA	Gray (RD3)

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Electrical General Requirements Section.

.2 Label must indicate:

.1 transformer "tag" as per riser diagram

.2 primary and secondary voltage and phase.

2.3 ACCEPTABLE MANUFACTURERS:

.1 Acceptable manufacturers are as follows:

.1 Hammond

.2 Rex

.3 Delta

.4 Acme

.5 Bemag

Part 3 Execution

3.1 INSTALLATION

.1 Primary and secondary feeders are to be connected using flexible conduit.

.2 Transformers with a rating up to and including 75 KVA are permitted to be wall mounted provided mounting method is a suitably sized angle iron frame secured to structure (i.e. masonry wall, steel columns, etc. NOT metal siding).

.3 The above rating of transformers may also be suspended from **structure only** on a unistrut trapeze as detailed.

.4 Transformers above 75 KVA must be floor mounted.

.5 Floor mounted transformers are to be mounted/secured to a concrete pad suitably sized to suit the transformer. This pad is the responsibility of this contractor and must be provided in conformance with the standard of Division 1 specifications for poured in place concrete.

.6 All transformers must be mounted on vibration isolators selected based on transformer weight.

.7 Ensure adequate clearance around transformer for ventilation as per the Electrical Safety Code.

.8 Loosen isolation pad bolts until no compression is visible.

.9 Install transformers in level upright position.

.10 Remove shipping supports only after transformer is installed and just before putting into service.

.11 Make primary and secondary connections in accordance with wiring diagram.

.12 Energize transformers after installation is complete.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Electrical General Requirements Section.

.2 Indicate on shop drawings.

.1 Floor anchoring method and foundation template.

.2 Dimensioned cable entry and exit locations.

.3 Dimensioned positions and size of bus.

.4 Overall length, height and depth.

.5 Dimensioned layout of internal and front panel mounted components.

1.2 MAINTENANCE DATA

.1 Provide maintenance data for service entrance board for incorporation into manual specified in the Electrical General Requirements Section.

.2 Submit 5 copies of maintenance data for complete assembly including components.

1.3 MAINTENANCE MATERIALS

.1 Include:

.1 One can of touch-up paint.

1.4 SOURCE QUALITY CONTROL

.1 Consultant to witness final factory tests if requested.

.2 Notify Consultant in writing 5 days in advance that service entrance board is ready for testing.

.3 Submit 5 copies of certified test results.

Part 2 Products

2.1 SERVICE ENTRANCE BOARD

.1 Service entrance board must conform to CSA C222 No. 31 (latest edition).

.2 Rating: 600V, 3 phase, 4 wire, 800A, short circuit current (kA rms symmetrical) as noted on distribution riser.

.3 Cubicles: wall-mounted/free standing, dead front, size as indicated, hinged access panels with captive knurled thumbscrews (front access only), EEMAC2 rating (sprinkler hood).

.4 Main section to contain:

Breakers as noted complete with kA interrupting capacity to match mains.

Barriered section for supply authority metering components.

Digital metering unit as specified.

NOTE: Refer to Moulded Case Circuit Breakers section for specifications regarding the required breakers.

.5 Distribution section to contain breakers as noted complete with kA interrupting capacity to match mains.

NOTE: Refer to Moulded Case Circuit Breakers section for specifications regarding the required breakers.

.6 Bus bars and main connections: aluminum.

.7 Bus bars from load terminals of main device through metering section to distribution section.

.8 Bus bars are to have identified colour coded phases.

2.2 GROUNDING

.1 Aluminum ground bus extending full width of cubicles and located at bottom.

.2 Lugs at each end for grounding cable. Contractor to size lug.

2.3 POWER SUPPLY AUTHORITY METERING

.1 Separate compartment and rigid metal raceway for exclusive use of power supply authority metering.

.2 Mounting accessories and wiring for metering supplied by power supply authority:

.1 3 current transformers.

2.4 FINISHES

.1 Apply finishes in accordance with the Electrical General Requirements Section.

.1 Service entrance board exterior: grey.

2.5 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Electrical General Requirements Section.

.2 Nameplates:

.1 Black plate, white letters, and size 7.

.2 Complete board labeled: 347/600V.

.3 Main disconnect labeled: Main Breaker

.4 Branch disconnects labeled: as indicated.

2.6 ACCEPTABLE PRODUCTS

.1 Maximum 1200A (up to 65kA bracing and interrupting rating)

- .1 Eaton Cat# CMP Series
- .2 Siemens Cat# SMP
- .3 Schneider Electric Cat# MDS

.2 Maximum 6000A (up to 200kA bracing and interrupting rating)

- .1 Eaton Cat# POW-R-LINE-C
- .2 Siemens Cat# SB
- .3 Schneider Electric Cat# QED

.3 Digital Metering Units

- .1 Eaton Cat# IQ 260 (MOD BUS) or Power Xpert 2000 Series (BACnet)
- .2 Siemens Cat# PAC 4200
- .3 Schneider Electric Cat# PM-5563RD.

.4 Digital metering units shall be complete with MOD BUS (BACnet) communication module for interface of monitored parameters to BAS. Coordinate output with BAS contractor.

.5 Manufacturer is to include for representative to visit the site to fully commission the meter.

Part 3 Execution

3.1 INSTALLATION

.1 Locate service entrance board and fasten to wall/housekeeping pad.

.2 Connect main secondary service to line terminals of main device.

.3 Connect load terminals of distribution devices to feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Run grounding conductors from ground bus to building ground to suit the Electrical Safety Code.

.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

.7 Co-ordinate with local supply authority and board manufacturer for shipment and installation of metering components at board manufacture’s fabrication plant.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

.1 Submit product data in accordance with Electrical General Requirements Section.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

Part 2 Products

2.1 PANELBOARDS

.1 Panel boards must conform to CSA C22.2 No. 29 (latest edition).

.2 Panelboards: product of one manufacturer.

.3 Install circuit breakers in panelboards before shipment.

.4 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand. **Series rating is acceptable – submit information with shop drawings. Provide lamicoid label on feeder breaker. Lamicoid label to state "Series Rating Breaker." Lamicoid label to be size 2.**

.5 Bus and breakers must be rated for [10,000] A (symmetrical) interrupting capacity or as indicated.

.6 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.7 Panelboard mains, number of circuits, and number and size of branch circuit breakers as indicated.

.8 Two keys for each panelboard and key panelboards alike.

.9 Aluminum bus with neutral of same ampere rating as mains.

.10 Mains must be suitable for bolt-on breakers. Provide main (if applicable) and branch breakers as bolt-on style.

.11 Trim with concealed front bolts and hinges.

.12 Trim and door finish must be baked grey enamel.

.13 All panels regardless of voltage and amperage must be provided with a lockable door.

.14 Branch circuit panelboards (250 AMP or smaller) must be one of the following:

- .1 Eaton Cat # POW-R-LINE-C PRL-1 or PRL-2
- .2 Schneider Electric Cat # NQ Series for up to 240V or NF Series for up to 600V
- .3 Siemens Cat #Sentron P1 Series

.15 Branch circuit panelboards indicated to be complete with an external surge protective device shall include a suitably sized branch circuit breaker for the surge protective device as noted on panel schedule, and per surge protective device manufacturer recommendations. Surge protective device shall be provided as specified in section 26 43 13, unless noted otherwise.

.16 Power distribution circuit breaker panelboards (400 AMP or larger) must be one of the following:

.1 Eaton CAT# POW-R-Line-C PRL-3A or PRL-4A

.2 Schneider Electric CAT# I-Line Series (Bolt-On)

.3 Siemens CAT# P2 Series (up to 600A mains and maximum 100A-3P branch breakers)

.4 Siemens CAT# S5 Series (up to 1200A mains with branch breakers above 100A-3P)

2.2 BREAKERS

.1 Breakers: to Moulded Case Circuit Breakers Section.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker (as specified) must be separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for fire alarm, stairway, exit and night light circuits.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Electrical General Requirements Section.

.2 Nameplate for each panelboard size 4 engraved description as indicated. In finished areas install label on inside of panel, and in service areas install label on exterior of panel.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved “name of load” as indicated.

.4 Complete circuit directory with typewritten legend showing location of each circuit. **Include a copy of the directories in the maintenance manuals.**

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard. Plywood shall be 21mm (3/4”) fire rated or painted with intumescent fire block paint having a minimum of 1h rating, unless noted otherwise.

.3 Mount panelboards to height specified in Electrical General Requirements Section or as indicated.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus.

.6 Mount external surge protective devices as close as possible to panelboard and associated branch breaker to minimize lead lengths and per manufacturers recommendations. Provide modified panel trim for flush mount applications as required to suit.

.7 Install series rating lamicoids adjacent to all breakers utilized to achieve series ratings.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

.1 Submit product data in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded case circuit breakers must conform to CSA C22.1 No.5.1-M91 (latest edition.)

.2 Bolt-on moulded case circuit breaker quick-make, quick-break type, for manual and automatic operation.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Unless otherwise indicated moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

.5 Moulded case circuit breakers 250 Amps and above are to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection (if indicated or applicable by the Electrical Safety Code versus the breaker amperage). Unless otherwise specified, complete system selective co-ordination shall be provided by the individually adjustable time/current curve shaping elements as following:

.1 Breakers shall have fixed rating plug determining breaker continuous current rating.

.2 All breakers shall have adjustable long delay pickup and time, L.

.3 All breakers shall have individual adjustments for short delay pickup and time, S; including I2t settings in time adjustment.

.4 Breakers shall have adjustable instantaneous pickup, I; that if required by co-ordination study can be turned off, (I).

.5 If required by Electrical Safety Code breakers shall have individually adjustable ground fault current pick-up and time, G; including I2t settings in time adjustment.

.6 Unless otherwise specified, for the low voltage systems provide an electronic trip unit as specified above for the following moulded case circuit breakers:

.1 Mains or ties in main switchboard: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at the point of installation.

.2 Transformer feeder for the units 225kVA and above: LSI or LS trip unit with fixed instantaneous over-ride, where instantaneous trip setting or instantaneous over-ride allows for transformer inrush of 12xFLA at 0.1s and exceeds maximum value of fault at the transformer secondary.

.3 Feeders exceeding 250A trip setting: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at downstream panelboard.

.4 Branch circuits or feeders for MCCs with fusible combination starters: LSI trip unit where instantaneous trip setting allows for maximum size downstream fuse total clearing time.

2.2 BREAKERS 1200A AND HIGHER

.1 Circuit breakers rated 1200A or higher must be equipped with Arc Flash Reduction Maintenance System (ARMS) in conformance with OESC 2024 2-306(3) to provide reduced arc fault clearing time.

.2 Unless otherwise indicated ARMS mode shall be enabled via integrated breaker mounted switch and indicating light.

.3 Arc Flash Reduction Maintenance System pickup settings shall be based on the project Arc Flash Hazard Reduction study.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated complete with all necessary mounting hardware and filler panels if necessary.

.2 Provie lamicoid labels for series rating breakers. Lamicoid label to state “Series Rating Breaker.” Lamicoid to be size 2.

.3 Provie lamicoid labels for ARMS capable breakers. Lamicoid label to state “Arc Flash Reduction Maintenance System Breaker.” Lamicoid to be size 2.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 SWITCHES

.1 Line Voltage Wall Switches

- .1 AC switches must conform to CSA C22.2 No. 111 (latest edition).
- .2 AC switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine molding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Toggle style (Rocker style) (architect to select colour).
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 AC Switches of one manufacturer throughout project.
- .5 Provide 2 keys per keyed switch.
- .6 Occupancy sensor switches shall be dual technology style (PIR and Ultrasonic) where noted on the drawings.
- .7 Acceptable Materials:
  - .1 Single Pole : Hubbell Cat #HBL1201
  - .2 Three Way: Hubbell Cat. #HBL1203
  - .3 Four Way: Hubbell Cat. #HBL1204
  - .4 Illuminated: Hubbell Cat. #HBL1221IL (light on with load off)
  - .5 Keyed: Hubbell Cat. #HBL1221 Series
    - .1 Keys: Hubbell Cat. #HBL1209
  - .6 Motor Rated: Hubbell Cat. #HBL1221PL
  - .7 Single Pole (Decora): Hubbell Cat #HBL2101
  - .8 Three Way (Decora): Hubbell Cat #HBL2103
  - .9 Four Way (Decora): Hubbell Cat. #HBL2124
  - .10 Single Relay Occupancy Sensor includes:
    - .1 Legrand Cat. #DW-100
    - .2 Greengate Cat. #ONW-D-1001
    - .3 Sensorswitch Cat. #WSXA Series

.11 Dual Relay Occupancy Sensor includes:

.1 Legrand Cat. #DW-200

.2 Greengate Cat. #ONW/VNW-D-1001-DMV-N

.3 Sensorswitch Cat. #WSXA Series

.8 Acceptable toggle switch alternate manufacturers include:

.1 Pass & Seymour

.2 Leviton.

.2 Line Voltage 0-10V Dimming Switches

.1 0-10V Dimmers are to be provided complete with the following features:

.1 Rating of 15A or 20A, 120V or 347V.

.2 0-10V dimming leads

.3 Capable of operation with four switch locations.

.4 DIP switches or local programming through switch buttons to change mode of operation.

.5 Integral on/off switch.

.6 Devices must mount in single gang box or multi-ganged where noted.

.7 Device and faceplate colour must match other wiring devices.

.8 Integral dual technology occupancy sensors (PIR and Ultrasonic).

.2 Acceptable Materials:

.1 0-10V Occupancy Wall Sensor Switch (Decora): Legrand Cat. #DW-311

.2 0-10V Dimming Switch: Leviton Cat. #ZS057 Series

.3 Acceptable alternative manufacturer's include:

.1 Legrand

.2 Leviton

.3 Lutron

.4 Sensor Switch

.5 Greengate

.3 Digital Interval Timer Switches

.1 Where noted supply and install a digital pre-set countdown time switch with the following features:

.1 minimum 1/6 HP rated contacts, mounted in recess single gang outlet box.

.2 Six (6) pre-set time selection buttons with options up to 1 hour.

.3 Unit shall be complete with activation indicator lights.

.4 Unit shall have integral On/Off button.

.5 White finish unless noted otherwise. (final finish selection by Architect).

.2 Acceptable Materials:

.1 Legrand Cat. #RT-50

.3 Acceptable alternative manufacturer's include:

.1 Leviton

.2 Lutron

.3 Hubbell

2.2 RECEPTACLES

.1 Receptacles, plugs, and other similar wiring devices must conform to CSA 22.2 No 42 (latest edition).

.2 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features (20A where noted):

.1 Urea molded housing (Colour by architect).

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and rivetted grounding contacts.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles of one manufacturer throughout project.

.5 Acceptable materials:

.1 Standard Devices

.1 Standard duplex receptacle: Hubbell Cat # HBL5252CN

.2 T-slot receptacles: Hubbell Cat. #HBL5352

.3 Tamper resistant receptacle: Hubbell Cat # BR15TR

.4 Tamper resistant T-slot receptacle: Hubbell Cat. #BR20TR

.5 Automatically Controlled Receptacles (Green): Hubbell Cat. #BR15C2GN(Green)

.2 Above 20A

.1 Dryer receptacle: Hubbell Cat # HBL9430A

.2 Range receptacle: Hubbell Cat # HBL9450A

.3 Decora Style Devices

.1 Decora Style: Surge duplex receptacle: Hubbell Cat. #HBL5260SA

.2 Ground fault protected T-slot receptacles: Hubbell Cat. # GF20L A

.3 USB charger duplex receptacles: Hubbell Cat. # USB15X2 XX

.4 USB charger T-slot receptacles: Hubbell Cat. #USB20X2 XX

.5 Decora style duplex receptacle: Hubbell Cat. # HBL2152

.6 Decora T-slot receptacle: Hubbell Cat. # HBL2162

.7 Decora tamper resistant receptacle: Hubbell Cat. #DR15TR

.8 Decora tamper resistant T-slot receptacle: Hubbell Cat. #DR20TR

.4 Tamper resistant

.1 Tamper resistant ground fault protected receptacle: Hubbell Cat. #GFTR15

.2 Tamper resistant ground fault protected T-slot receptacle: Hubbell Cat. #GFTR20

.3 Tamper resistant duplex receptacle complete with dual USB ports: Hubbell Cat. #USB15XXX

.4 Automatically Controlled Tamper Resistant Receptacles (Green): Hubbell Cat. #BR15C2GNTR

.5 Hospital grade decora style duplex receptacle for patient care environments or as otherwise indicated on plans:

Hubbell Cat. #2172RW

.6 Acceptable alternate manufacturers include:

.1 Pass & Seymour

.2 Leviton

.7 Residential grade equivalents for materials noted above for use within residential dwelling units.

2.3 COVER PLATES

.1 Cover plates from one manufacturer throughout project.

.2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.3 Stainless steel, brushed, 1 mm (1/32") thick cover plates for wiring devices mounted in flush-mounted outlet box.

.4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.5 Weatherproof cover plates complete with gaskets and “heavy-duty in use” covers in conformance with the Electrical Safety Authority. Provide product equal to Intermatic Cat. #WP5100C.

.6 Where noted on plans for exterior weatherproof GFCI receptacles at grade, provide extra-duty single gang horizontal die cast receptacle covers. NEMA 3R rated complete with lockable hasp and reinforced hinge. Suitable for use with 12-gauge cord sets. Intermatic Cat. # WP1010HMXD or equal.

.7 Where noted on plans for exterior weatherproof cover plates at GFCI receptacles on residential balconies above grade, within 760mm of balcony railing, to avoid climbing hazard provide product equal to Intermatic Cat. #WP7000 (low-profile, in-use, extra-duty).

.8 Provide p-touch labels on cover plates for all receptacles. Labels shall include source panel and branch circuit, including switch leg indicator as applicable for automatically controlled receptacles.

Part 3 Execution

3.1 INSTALLATION

.1 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.3 Mount toggle switches at height specified in Electrical General Requirements Section or as indicated.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Mount receptacles at height specified in Electrical General Requirements Section or as indicated.

.3 Where split receptacle has one portion switched mount vertically and switch upper portion.

.3 Occupancy sensors:

.1 Occupancy sensors shall be set to 5 minutes “delay to off” unless otherwise noted.

.4 Occupancy sensors and dimmers:

.1 Switches with occupancy sensors and dimmers shall be programmed as follows:

.1 5 minutes “delay to off” unless otherwise noted.

.2 “Auto on” to 50% dimming level.

.5 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.6 Dimmer:

.1 Dimming Switches

.1 Mount devices at height as specified in Electrical General Requirements Section.

.2 Install in upright position as per manufacturer’s installation instructions.

.3 Provide class II 0-10V control wiring from 0-10V dimming switch to each fixture driver in 21mmC.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

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

.2 CSA C22.2 No. 106-M92 (latest edition).

1.2 MAINTENANCE MATERIAL

.1 Three spare fuses of each type and size installed.

1.3 DELIVERY AND STORAGE

.1 Ship fuses in original containers.

.2 Store fuses in original containers in moisture free location.

Part 2 Products

2.1 FUSES GENERAL

.1 Fuses: product of one manufacturer for entire project.

.2 Fuses specified below must conform to CSA C22.2 No. 106 (latest edition). Fuses conforming to standard C22.2 No. 106-1953 will be rejected.

.3 Fuses must provide a fully co-ordinated system for both overload and fault conditions.

2.2 FUSE TYPES

.1 Class L fuses (formerly HRC-L) for ratings 601-6000 A.

.1 Time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Fast acting as noted.

.2 Class J fuses (formerly HRCI- J).

.1 Time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Fast acting as noted.

.3 Class R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and I^2t values not to exceed limits of UL 198E-1982, table 10.2.

2.3 ACCEPTABLE PRODUCTS

.1 Service Entrance:

1-600 A: Mersen Type CJ

601-6000 A: Mersen Type CL

.2 Motor Protection:

1-600 A: Mersen Type AJT

601-2000 A: Mersen Type A4BT

.3 Other acceptable manufacturers:

.1 GEC

.2 Little Fuse

Part 3 Execution

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.

.1 Install Class R rejection clips for HRCI-R fuses.

.3 Ensure correct fuses fitted to assigned electrical circuit.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

.1 Submit product data in accordance with Electrical General Requirements Section.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Enclosed manual air break switches must conform to CSA C22.1 No.4 (latest edition).

.2 Fuseholder assemblies must conform to CSA C22.2 No.39 (latest edition).

.3 Fusible, and/or non-fusible, horsepower rated disconnect switches, size as indicated.

.4 Provision for padlocking in off switch position by three locks.

.5 Mechanically interlocked door to prevent opening when handle in ON position.

.6 Fuses: size as indicated, to Fuses - Low Voltage Section.

.7 Fuseholders: relocatable and suitable without adaptors, for type and size of fuse indicated.

.8 Quick-make, quick-break action.

.9 ON-OFF switch position indication on switch enclosure cover.

.10 Disconnects feeding elevator controllers must be equipped with two auxiliary contacts approved by the elevator supplier.

.11 Service entrance rated with fault bracing, fusing and barrier as required.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Electrical General Requirements Section.

.2 Indicate name of load controlled on size 4 nameplate.

2.3 ACCEPTABLE MANUFACTURERS

Manufacturer	General Purpose	Weather Proof
Eaton	IHD Series	3HD Series
Schneider Electric	Type A Series	Type R Series
Siemens	ID Series	NFR/FR Series

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

.2 Connect auxiliary contacts to elevator controller using conduit, wire and route approved by the elevator supplier.

.3 Disconnect switches mounted on mechanical rooftop equipment shall be installed minimum 750 mm (30") above finished roof to be protected against damage and weather (snow build up).

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Electrical General Requirements Section.

.2 Indicate:

.1 Mounting method and dimensions.

.2 Starter/contactor size and type.

.3 Layout of identified internal and front panel components.

.4 Enclosure types.

.5 Wiring diagram for each type of starter.

.6 Interconnection diagrams.

1.2 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for incorporation into manual specified in Electrical General Requirements Section.

.2 Include operation and maintenance data for each type and style of starter/contactor.

1.3 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Electrical General Requirements Section.

.2 Provide listed spare parts for each different size and type of starter:

.1 1 operating coil.

.2 3 fuses.

.3 10% indicating lamp bulbs used.

Part 2 Products

2.1 MATERIALS

.1 Starters: must conform to CSAC22.2 No. 14 (latest edition) and EEMAC E14-1.

.2 Control transformers must conform to CSAC22.2 No. 66 (latest edition).

.3 Auto-transformers must conform to CSAC22.2 No 47 (latest edition).

.4 Contactors must conform to CSA C22.2 No. 14 (latest edition).

.5 Half size starters will not be accepted. NEMA and IEC rated starters are acceptable.

2.2 MANUAL MOTOR STARTERS

.1 Single and Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break.

.2 One or Three overload heaters, manual reset, trip indicating handle.

.3 Toggle switch: standard duty labeled “on”/“off”.

.4 Indicating light: standard duty type and red colour.

.5 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Pushbuttons Selector switches standard duty labeled as indicated.

.2 Indicating lights: standard duty type and color as indicated.

.3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

.4 1 red pilot light for “stop” or “off” and 1 green light for “start” or “on”.

2.4 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and secondary voltage to suit remote control device, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.5 CONTACTORS

.1 Electrically held and controlled by pilot devices as indicated and rated for type of load controlled.

.2 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.3 Mount in CSA Enclosure 1 unless otherwise indicated.

.4 Include following options in cover:

.1 Red indicating lamp.

.2 Hand - Off - Auto selector switch.

.5 Control transformer: mounted in contactor enclosure.

.6 Contactors must be definite purpose.

2.6 FINISHES

.1 Apply finishes to enclosure in accordance with Electrical General Requirements Section.

2.7 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Electrical General Requirements Section.

.2 Manual starter designation label: black plate, white letters, size 1, engraved as indicated.

.3 Magnetic starter designation label: black plate, white letters, size 2, engraved as indicated.

.4 Contactor designation label:

black plate, white letters, size 4, indicating name of load controlled.

2.8 ACCEPTABLE MANUFACTURERS

.1 The acceptable manufacturers are as follows:

.1 Allen Bradley

.2 Eaton

.3 Siemens

.4 Group Schneider

.5 Klockner Moeller

Part 3 Execution

3.1 INSTALLATION

.1 Install starters, connect power and control as indicated.

.2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Electrical General Requirements Section.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

.5 Install contactors and connect auxiliary control devices.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy transient voltage surge suppressors. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.4.1.1 Category A, B and C environments (as tested by ANSI/IEEE C62).

1.2 STANDARDS

.1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

- .1 Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
- .2 American National Standards Institute
- .3 National Electrical Manufacturer Association (NEMA LS-1 1992 Peak Current Testing)
- .4 Electrical and Electronic Mfg. Association of Canada (EEMAC)
- .5 National Fire Protection Association (NFPA 75 and 780)
- .6 MIL Standard 220A Method of Insertion Loss Measurement
- .7 Ontario Electrical Code
- .8 Underwriters Laboratories UL 1283 and UL 1449 (latest edition)
- .9 Canadian Standards (CUL)

1.3 ENVIRONMENTAL REQUIREMENTS

.1 The operating temperature range shall be -40° to 70°C (-40° to 160°F).

.2 No appreciable magnetic fields shall be generated.

1.4 SUBMITTALS

.1 Product Data: Provide catalog sheets showing voltage, physical size, IEEE let through voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.

.2 Submit product data for all components and accessories per section 26 01 16 ‘Electrical General Requirements’.

.3 Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.

.4 List and detail all protection systems such as fuses, disconnecting means and protective features.

.5 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA approvals.

.6 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.

.7 Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.

.8 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.5 QUALITY ASSURANCE AND WARRANTY

.1 The panel mounted SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of thirty (30) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, during the applicable warranty period, any SPD which fails due to any electrical anomaly, including lightning, shall be repaired or replaced by the manufacturer without charge. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

.2 The warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only. Special warranties for the purpose of this bid are not allowed.

.3 If the SPD units supplied do not meet the specifications as written, contractor will remove units and re-install approved SPD units to the satisfaction of the consultant. Contractor will be responsible for any and all costs associated with re-installation.

Part 2 Products

2.1 PERFORMANCE

.1 The SPD shall be listed by ETL, UL, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 standards (latest edition), and not merely the components or modules. All SPDs shall be Type 1 for use in Type 1 and Type 2 locations.

.2 The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.

.3 Obtain all surge suppression devices through one source from a single manufacturer.

.4 The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 208 systems, and 115% for 347 and 600V systems.

.5 All SPDs shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.

.6 Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory. The manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a UL1449 Second Edition surge defined as a 1.2 X 50 µsec 6000V open circuit voltage waveform and an 8 X 20 µsec 500A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an approximated 8 X 20 µsec waveform. To complete the test, another UL1449 surge shall be applied to verify the unit's survival. Compliance is achieved if the suppression voltage found from the two UL1449 surges does not vary by more than +10%. Test data on an individual module is not acceptable.

.7 SPD manufacturer shall be Total Protection Solutions Canada, as provided by Innosys Power Inc. and represented by Medgar LCI (Contact Scott McGregor, Ph: 519-500-7120).

2.2 SERVICE ENTRANCE PROTECTION

.1 The SPD for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPDs shall be certified to UL1283 and UL 1449 (latest edition). Type 1 for use in Type 1 or Type 2 locations. All SPD units shall be RoHS compliant.

Medium to Low Exposure: Up to 1200 amps Service entrance panels shall be protected by a 240Ka Total Protection Solutions) panel mounted SPD, model TK-ST240-3Y600-L for 347/600 wye (4W+G) volt panels and model TK-ST240-3Y208-L for 120/208 wye (4W+G) volt panels.

.2 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories C1and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage
B3/C1 Impulse (6kV, 3kA)

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	502V	627V	864V	568V
347/600 (3Y600)	1090V	1144V	2017V	1155V

C3 Impulse (20kV, 10kA)

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	907V	1173V	1267V	1090V
347/600 (3Y600)	1537V	1707V	2470V	1800V

UL Voltage Protection Ratings

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	800V	800V	1200V	800V
347/600 (3Y600)	1500V	1500V	2500V	1500V

.3 The unit shall have a peak surge current of no less than 200kA/mode, 8 X 20 us waveform, single impulse, independently verified.

.4 Internal Fusing - Over current Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Over current fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode over current fusing is not acceptable where there is more than one MOV per mode.

.2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.

.3 Fusing shall be present in every mode, including Neutral-to-Ground.

.4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

.5 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a EEMAC 2 steel enclosure.

.6 The SPD shall have an internal audible alarm with mute on front cover.

.7 SPDs for service entrance locations shall have a transient event counter with LCD panel display and reset button on the front cover.

.8 When SPD lead lengths exceed four (4) feet, low impedance cable (LIC) supplied by the SPD manufacturer shall be utilized. LIC shall have effective lead impedance min. 75% less than standard cable, and shall have nominal impedance, capacitance and inductance values that do not exceed the following:

Nominal Impedance (@10kHz, ohms/ft) Nominal Capacitance

(pf/ft) Nominal Inductance

(µH/ft)

Line	0.009	35.6	0.098
Neutral	0.004	52.6	0.041
Ground	0.004	571	0.021

SPDs shall be installed such that lead length is minimized.

2.3 DISTRIBUTION PANEL AND MOTOR CONTROL CENTER PROTECTION

.1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panel board. Integral SPD shall not be acceptable. SPDs shall be certified to UL 1283 and UL1449 (latest edition). Type 1 for use in Type 1 and Type 2 locations.

.2 Distribution Panels and MCCs shall be protected by a Total Protection Solutions panel mounted SPD, model TK-ST160-600NN-FL for 600 (3W+G) volt panels, model TK-ST160-3Y600-FL for 347/600 (4W+G) volt panels and model TK-ST160-3Y208-FL for 120/208 (4W+G) volt panels.

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B3/C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

B3/C1 Impulse (6kV, 3kA)

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	502V	627V	864V	568V
347/600 (3Y600)	1090V	1144V	2017V	1155V

C3 Impulse (20kV, 10kA)

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	907V	1173V	1267V	1090V
347/600 (3Y600)	1537V	1707V	2470V	1800V

UL Voltage Protection Ratings

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	800V	800V	1200V	800V
347/600 (3Y600)	1500V	1500V	2500V	1500V

.4 The unit shall have a peak surge current of no less than 160kA/phase, 80kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Internal Fusing - Over current Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Over current fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode over current fusing is not acceptable where there is more than one MOV per mode.

.2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.

.3 Fusing shall be present in every mode, including Neutral-to-Ground.

.4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

.6 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.

.7 The SPD shall have an internal audible alarm with mute on front cover.

2.4 SUBPANEL AND LIGHTING PANEL PROTECTION

.1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panel board. Integral SPD shall not be acceptable. SPDs shall be certified to UL1283 and UL1449 (latest edition). Type 1 for use in Type 1 and Type 2 locations.

.2 Subpanels and lighting panels shall be protected by a panel mounted SPD, TK-LP120-3Y208-L-F for 120/208 (4W+G) volt recessed panels and TK-TT2-065-3Y208-FL for surface mounted panels.

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

A1 Ring Wave (2kV, 67A)	Tested at 180 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	29V	46V	39V	40V

A3 Ring Wave (6kV, 200A)	Tested at 180 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	56V	61V	88V	112V

B3 Ring Wave (6kV, 500A)	Tested at 90 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	437V	592V	612V	324V

UL Voltage Protection Ratings

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	700V	700V	1000V	700V

.4 The unit shall have a peak surge current of no less than 120kA/phase, 60kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Internal Fusing - Over current Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Over current fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode over current fusing is not acceptable where there is more than one MOV per mode.

.2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.

.3 Fusing shall be present in every mode, including Neutral-to-Ground.

.4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

.6 The SPD shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.

.7 Due to space limitations, the enclosure shall not exceed 4.0" D x 4.0" W x 10.3" H to allow close-to-the load installation on flush mount panels and between adjacent panel board. For recessed panels, a flush mount cover plate shall be provided with each unit along with a flush mount accessory kit Cat. #LP-FMP.

.8 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 1 steel enclosure.

.9 The SPD shall have an internal audible alarm with mute on front cover.

2.5 PHONE LINE PROTECTION

.1 The telephone line surge suppressors shall be Total Protection Solutions model TK-CT2-190TLP4-TB for 4 pair. Coordinate with owner IT representative for phone service characteristics. Provide a minimum of terminal block suppression units to handle a minimum of telephone lines.

.2 The unit shall be listed under UL 497A, Standard for Secondary Protectors for Communications Circuits.

.3 The unit shall have a data transmission rate up to 16.0 Mbps.

.4 Each conductor shall have less than 1 ohm of internal series resistance per wire.

.5 Each pair of conductors shall have a peak surge current of no less than 2,000 amps, 8 x 20 us waveform.

.6 The suppressor shall come standard with not less than a ten year warranty which provides for unlimited free replacements of damaged units. Special warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

.7 The maximum let-through voltage on an IEC 10 x 700 us impulse (2kV/80A) shall be 240 volts tip-ring, 240 volts tip to ground, and 240 volts ring to ground.

.8 The response time of the components of the unit shall be less than one nanosecond.

.9 Obtain all surge suppression devices through one source from a single manufacturer.

.10 For quality assurance, manufacturer must provide proof that manufacturer has been regularly engaged in the design, manufacturing and testing of SPDs of the types and ratings required for a period of not less than five years.

Part 3 Execution

3.1 INSTALLATION

.1 Install the SPDs with the conductors as short and straight as practically possible.

.2 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.

.3 Main service entrance units shall be installed on a 60 amp breaker that meets or exceeds the fault current rating of the switchgear.

.4 Distribution, branch panel, and motor control center units shall be installed on 30 amp dedicated circuit breakers, or, where indicated, shall be wired directly to the main lugs or feed through lugs, or wired directly to the bus bars.

.5 The installing contractor shall comply with all applicable codes.

.6 SPD units shall be wired such that connection cable lead lengths are minimized. SPD manufacturer to advise installing contractor on required locations of low impedance cables (LICs).

.7 **SPD manufacturer shall include in tender for pre-installation visit to the job site to confirm recommended installation methods. Indicate provision for this visit on shop drawing submission.**

.8 **The entire SPD installation must be inspected by an authorized manufacturer's representative and supply certificate of completion. This cost shall be included in the tender price. Indicate provision for this inspection on shop drawing submission.**

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE C62.41- 1991, Recommended Practices for Surge Voltages in Low-Voltage AC Power Circuits.

.2 American Society for Testing and Materials (ASTM)

.1 ASTM F1137- 88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.3 United States of America, Federal Communications Commission (FCC)

.1 FCC (CFR47) EM and RF Interference Suppression.

.4 IESNA LM-79-08, IES Electrical Method for the Electrical and Photometric Measurements of Solid State Lighting Products.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Electrical General Requirements Section for all light fixtures supplied under this contract.

.2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.

.3 Photometric data to include: VCP Table spacing criterion.

1.3 SCOPE

.1 This contractor is responsible to supply and install all lighting fixtures as scheduled and/or indicated including lamp and those accessories required for a complete lighting system. This contractor must coordinate lighting installations with all other Divisions of this project.

.2 All fixtures must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority.

1.4 GUARANTEE

.1 Guarantees for materials replacement shall be as follows from date of ready for takeover.

.1 LED lamps: 3 months

.2 LED fixtures, and driver: 5 years.

.2 The labour required to replace these ballasts, lamps or drivers must be included in the above guarantee, however only for the extent of the contract guarantee and warranty period as noted in Electrical General Requirements.

Part 2 Products

2.1 FIXTURE CONSTRUCTION

.1 Fixtures must be constructed of 20 gauge (minimum) cold rolled steel. All metal edges require smooth finish.

.2 Light leaks must be prevented by providing gasketting, stops, and barriers.

.3 Fixtures must be finished in high reflective baked white enamel. This surface must have a reflectance of not less than 85%.

.4 All fixtures operating on 347 Volts must be provided with an integral disconnecting means.

2.2 FIXTURE LENS

.1 Unless otherwise noted fixture lenses shall be as follows:

.1 Lens thickness: 3.2 mm (1/8")

.2 Material: injection moulded clear prismatic virgin acrylic

.3 Frame: hinged, latched, steel.

2.3 LED FIXTURES

.1 Fixture LEDs must be tested in conformance with IESNA LM80 standard.

.2 LEDs must be selected using a binning algorithm to ensure colour and lumen output of a given fixture are consistent, as well as meet or surpass ANSI C78.377 specification for the rated lifetime of the fixture. Colour accuracy between products must be within a 2-step MacAdam ellipse.

.3 Luminaires must be tested to IESNA LM79 by an independent approved laboratory.

.4 Luminaires must be tested prior to shipping.

.5 Luminaires must be ULC certified and approved for use in Canada.

.6 Fixtures must maintain a minimum of 90% of their initial light output for 60,000 hours. Submit test results upon request.

.7 Lumen values indicated for fixtures in the project documents are to be considered as “absolute” or “delivered” values.

.8 Other than for specialty fixtures, and unless otherwise indicated, the maximum driver current is to be 750 mA.

2.4 STANDARD EXIT LIGHTING UNITS

.1 Exit lighting units must conform to CSA C860, CSA 22.2 No. 141 (latest edition).

.2 Housing: extruded aluminum housing, white finish.

.3 Face and back plates: extruded aluminum.

.4 Lamps: 2W LED.

.5 Operation: 25 year.

.6 Units are to be provided with three (3) pictogram legends indicating “left from here”, “straight from here”, and “right from here”.

.7 Face plate to remain captive for relamping.

2.5 SELF-POWERED COMBINATION EXIT/EMERGENCY LIGHTING UNITS

.1 Exit lighting units must conform to CSA C860, CSA 22.2 No. 141 (latest edition).

.2 Housing: Extruded aluminum housing. White Finish.

.3 Face and back plates: Extruded aluminum.

.4 Lamps 2W LED (EXIT).

.5 Operation: 25 year life.

.6 Units are to be provided with three (3) pictogram legends indicating “left from here”, “straight from here”, and “right from here”.

.7 Face plate to remain captive for relamping.

.8 Supply voltage: As noted on drawings.

.9 Output voltage: 12 V DC.

.10 Battery: Sealed maintenance free 10 year life.

Note: Battery must be capable of supplying the wattage indicated for a minimum of 30 minutes.

.11 Charger: Solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.

.12 Solid state transfer circuit.

.13 Signal lights: “AC Power On” condition and “charging” condition.

.14 Lamp heads: Integral on unit, 345º horizontal and 180º vertical adjustment. Lamp type: minimum 4 watt LED.

.15 Mounting: Suitable for universal mounting directly on junction box and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.16 Cabinet: finish: White.

.17 Auxiliary equipment:

.1 Test switch.

2.6 EMERGENCY LIGHTING UNITS

.1 Emergency lighting units must conform to CSA C22.2 No 141 (latest edition).

.2 Supply voltage: As noted on drawings.

.3 Output voltage: 12 V DC.

.4 Battery: Sealed, maintenance free, 10 year life.

Note: Battery units must be capable of supplying the wattage indicated for a minimum of 30 minutes.

.5 Charger: Solid state, multi rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

.6 Solid state transfer circuit.

.7 Low voltage disconnect: Solid state, modular, operates at 80% battery output voltage.

.8 Signal lights: “AC Power ON” condition and “charging” condition.

.9 Lamp heads: Integral on unit, 345º horizontal and 180º vertical adjustment. Lamp type: minimum 4 watt LED.

.10 Cabinet suitable for direct of shelf mounting to wall and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.11 Auxiliary equipment:

.1 Test switch.

.2 Ac input and DC output terminal blocks inside cabinet.

.3 Shelf.

.4 Cord and plug connection for AC. **(Not applicable on 347 V units)**.

2.7 REMOTE EMERGENCY LIGHTING FIXTURES

.1 Remote emergency lighting fixtures must conform to CSA C22.2 No141 (latest edition).

.2 Fixtures shall be small “micro” size or recessed style as indicated in the Light Fixture Schedule.

.3 Fixtures must be adjustable type heads with canopy.

.4 Fixtures are to be provided with protective lexan cube when specified in the Light Fixture Schedule.

.5 Unless otherwise indicated surface mounted fixtures in washrooms, locker rooms, changerooms, and gymnasiums must be provided with wire guard.

2.8 ACCEPTABLE LIGHTING MANUFACTURERS

.1 Refer to the light fixture schedule as indicated on drawings.

2.9 ACCEPTABLE FIXTURE ENERGY LISTINGS

.1 Fixtures as noted on lighting fixture schedules are to be DLC or Energy Star listed as noted. Equal manufacturers shall supply proof of DLC/Energy Star listing as part of fixture approval and shop drawing process.

Part 3 Execution

3.1 INSTALLATION

.1 Locate and install luminaires as indicated. Luminaires are not to be supported from the roof deck. Provide additional Unistrut support channel and/or support from structure. Co-ordinate with consultant on site.

.2 Ball align hangers must be provided for rod suspended fixtures.

.3 Fixtures surface mounted to suspended ceilings must be secured through ceiling assembly to cross member supports. These supports are to be steel channels or angles independently secured **to structure** using # 12 “jack” chain. Each chain must be secured so no fixture weight is added to the ceiling assembly.

.4 Plaster frames/flange kits must be provided by this Division for fixtures recessed in plaster and/or drywall ceilings.

.5 Where specified, fixtures to be chain hung shall be hung using “jack” chain with a capacity to suit the fixture weight. Branch circuit wiring feeding these fixtures shall be AC90 cable “ty-wrapped” at 900 mm (36") intervals along length of drop. Final appearance must be neat and professional.

.6 Install exit lighting units with illuminated faces and chevrons/arrows indicating path(s) of exit as indicated. Unless otherwise noted install exit fixtures at 2400 mm (8'-0") above finished floor.

.7 Install emergency lighting units and associated remote mounted fixtures as indicated.

.8 Direct “heads” on units and remote mounted fixtures to illuminate path(s) of exit.

.9 Install emergency lighting units and remote fixtures at 300 mm (12") below finished ceiling, unless indicated otherwise.

.10 Provide a 15 A 120 V duplex receptacle (connected to circuit indicated) adjacent to unit. **Not applicable on 347 V units. This receptacle connection is to be no lower than 8'-0" (2400 mm) AFF.**

.11 Special installation: Secure fixtures to structure to conform to the Electrical Safety Code using “jack chain” NOT ceiling suspension wire. Where coreslab is used, suspension point must be independent of the one used for suspension of the ceiling assembly. As an alternate to jack chain the contractor may use a pre-manufactured aircraft cable suspension and fastening system as manufactured by Gripple (Gripple Cat. #HF02-10F2). Provide minimum 2 per fixture.

.12 All battery units are to be provided with a visible lamicoid label indicating the unit number as per drawings.

3.2 WIRING

.1 Connect luminaires to lighting circuits as indicated.

.2 Connect exit fixtures to exit lighting circuits and unit equipment (if applicable).

.3 Connect unit equipment to circuits as indicated.

.4 All wiring of remote emergency fixtures shall be minimum #10 T90 for each circuit and run in conduit. Wiring must be sized in conformance with manufacturer's recommendations for distances required.

3.3 LUMINAIRE ALIGNMENT

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.4 DELIVERIES

.1 Fixtures are to be completely assembled at the manufacturer's plant and delivered to the project site in original unitized containers. Ensure that a dry, protected and secure space is available for proper storage before scheduling delivery of fixtures.

3.5 TESTING/CERTIFICATION

.1 At the completion of the project and in the presence of the consultant, test all exit and emergency fixtures. On company letterhead, the contractor is to prepare a chart indicating:

.1 Project
.2 Date
.3 Equipment type
.4 Certification of correct connection
.5 Certification of correct operation
.6 Duration of test in minutes (minimum 30)
.7 Actual period of testing (time of day)

3.6 INTEGRATED LIFE SAFETY SYSTEM TESTING

.1 This electrical contractor shall participate in integrated testing of this life safety system in conformance with Electrical General Requirements. Include all associated costs in tender.

3.7 ADDITIONAL INSTALLED EXIT SIGNS

.1 The electrical contractor is to include in their bid the cost to add three (3) additional standard exit lighting units to be installed and tested in locations as directed by the consultant. Note: This installation and test will be occurring after the initial testing/certification testing is complete.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 The lighting controls system will be supplied as a cash allowance. This section includes information on the system for pricing of installation. This is a wired lighting control system utilizing low voltage network cabling, comprised of the following components:

- .1 System Software Interfaces
  - .1 Management Interface
  - .2 Visualization Interface
- .2 Wired Control System Devices
  - .1 Wall Stations
  - .2 Digital Key Switches
  - .3 Auxiliary Input/Output Devices
  - .4 Occupancy and Photocell Sensors
  - .5 Wall Switch Sensors
  - .6 Relay Packs and Secondary Relays

.2 The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

.3 All equipment must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority.

.4 Reference section 26 51 13 for Lighting information.

.5 Reference section 26 27 26 Wiring Devices for wall mounted sensor switches.

.6 Reference section 26 05 75 for Line Voltage Power Packs and associated analog sensors.

1.2 SUBMITTALS

.1 Submit shop drawings in accordance with Section 26 01 16.

.2 Submit composite wiring diagrams and control schedule for each room control circuit type as proposed to be installed. Include load type, sequence of operation, sensor parameters, time delays, sensitivities and daylighting set points.

.3 Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

1.3 QUALITY ASSURANCE

.1 Product Qualifications

- .1 System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled with required markings as applicable.

.2 System luminaires and controls shall be certified by the manufacturer to have been designed, manufactured, and tested for interoperability.

.2 Installation and Startup Qualifications

.1 System startup shall be performed by qualified personnel approved or certified by the manufacturer.

.3 Service and Support Requirements

.1 Phone Support: Toll-free technical support shall be available. The manufacturer shall provide an online tool to schedule a technical support appointment. Manufacturer shall provide 24/7 emergency support.

.2 Onsite Support: The manufacturer shall offer onsite support that is billable.

1.4 WARRANTY

.1 The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of shipment.

.2 The hardware warranty shall cover repair or replacement of any defective products within the warranty period.

Part 2 Equipment

2.1 SYSTEM PERFORMANCE REQUIREMENTS

.1 System Architecture

.1 System shall have an architecture that is based upon these main concepts: (1) plug and play (local network) intelligent lighting control devices, and (2) standalone lighting control zones using distributed intelligence.

.2 Intelligent lighting control devices shall have individually addressable local network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.

.3 System must be capable of interfacing directly with integrated controls luminaires such that low voltage network cabling is used to interconnect luminaires with control components such as sensors, switches and system backbone.

.4 Intelligent lighting control devices shall support individual (unique) configuration of device settings and properties, with such configuration residing within the controlled luminaires and intelligent control devices.

.5 Lighting control zones consisting of one or more intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”

.1 Lighting control zones (wired) of at least 128 devices per zone shall be supported.

.6 Intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.

.7 All system devices shall support firmware update, either remotely or from within the applications space, for purposes of upgrading functionality at a later date.

.2 Wired Networked Control Zone Characteristics

.1 Connections to devices within a wired lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.

.2 Devices in an area shall be connected via a “daisy-chain” topology. “Hub-and-spoke” topology, requiring all individual networked devices to be connected back to a central component, shall not be permitted, so as to reduce the total amount of network cable required for each control zone.

.3 System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware to reduce the opportunity for improper wiring and communication errors during system installation.

.4 Following proper installation and provision of power, all devices connected with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g. software application, handheld remote, pushbutton).

.1 The “out of box” default sequence of operation is intended to provide typical sequence of operation to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.

.5 Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.

.6 All devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

.7 Control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:

.1 Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.

.2 UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard, and shall automatically close the load control relay and provide 100% light output upon detection of loss of power sensed via line voltage connection to normal power.

.8 Wired networked Wall stations shall provide the follow Scene Control Capabilities:

.1 Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.

.2 Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as supporting “Local Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage.

.1 Wall stations shall be able to manually start and stop Local Profiles, or the local profile shall be capable of ending after a specific duration of time between 5 minutes and 12 hours.

.2 Parameters that shall be configurable and assigned to a Local Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.

.3 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local and global control zones, so as to support “multi-way” preset scene and profile scene control.

.3 Supported Sequence of Operations

.1 Control Zones

.1 Intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.

.2 Wall station Capabilities

.1 Wall stations shall be provided to support the following capabilities:

.1 On/Off of a local control zone.

.2 Continuous dimming control of light level of a local control zone.

.2 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local control zones, so as to support "multi-way" switching and/or dimming control.

.3 Occupancy Sensing Capabilities

.1 Occupancy sensors shall be configurable to control a local zone.

.2 Multiple occupancy sensors shall be capable of controlling the same local zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.

.3 System shall support the following types of occupancy sensing sequence of operations:

.1 On/Off Occupancy Sensing

.2 Partial-On Occupancy Sensing

.3 Partial-Off Occupancy Sensing

.4 On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:

.1 Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.

.2 Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.

.3 To provide additional energy savings the system shall also be capable of combining Partial-Off and Full-Off operation by dimming the lights to a designated level when vacant and then turning the lights off completely after an additional amount of time.

.4 Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under *Photocell Sensing Capabilities.*

.5 The use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.

.5 To accommodate diverse types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.

.4 Photocell Sensing Capabilities (Automatic Daylight Sensing)

.1 Photocell sensing devices shall be configurable to control a local zone.

.2 The system shall support the following type of photocell-based control:

.1 Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

2.2 SYSTEM CABLING REQUIREMENTS

.1 Provide conduit and cabling for all Lighting Control Systems.

.2 Controls devices are to be installed, cabled, and connected by this electrical contractor.

.3 Electrical design drawing lighting control schematics are generic and meant to show intent of controls approach. Contact lighting control system manufacturer rep for lighting control system schematics, wiring diagrams, controls risers, sensor layouts, etc. and installation instructions prior to bid.

.4 All devices have RJ-45 female ports. Making network control cables on site is required.

.5 Cabling for system shall be Category 5e as per manufacturer's recommendations.

.1 Cable shall be 4 pair, 24 AWG solid bare annealed copper conductors, ANSI/TIA/EIA-568-B.2 and ISO/IEC 11801 category 5e compliant.

.2 The jacket shall be printed with TRU-Mark™ 1000' to 0' marking system, CMP (FT-6) rated with outer sheath colour for each level in the system to be according to advisement by school board representative

.3 Shall be suitable for use indoor, riser or plenum, and horizontal applications.

2.3 SYSTEM PROGRAMMING REQUIREMENTS

.1 Programming capabilities shall include the following:

.1 Switch/occupancy/photosensor zone configuration.

.2 Manual/automatic on modes.

.3 Turn-on dim level.

.4 Occupancy sensor time delays.

.5 Dual technology occupancy sensors sensitivity.

.6 Photosensor calibration adjustment and auto-setpoint.

.7 Multiple photosensor zone offset.

.8 Trim level settings.

.9 Preset scene creation and copy for scene capable devices.

.10 Application of custom device labels to individual connected lighting control devices.

2.4 WIRED DEVICES

.1 Wired Wall Switches, Dimmers, Scene Controllers

.1 Devices shall recess into single-gang switch box and fit a standard Decorator opening.

.2 Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

.3 All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.

.4 Devices with mechanical push-buttons shall provide tactile and LED user feedback.

.5 Devices with mechanical push-buttons shall be made available with custom button labeling.

.6 Wall switches & dimmers shall support the following device options:

.1 Number of control zones: 1, 2 or 4

.2 Control Types Supported:

.1 On/Off

.2 On/Off/Dimming

.3 On/Off/Dimming/Correlated Color Temperature Control for specific luminaire types

.3 Colors: Ivory, White, Light Almond, Gray, Black, Red

.7 Scene controllers shall support the following device options:

.1 Number of scenes: 1, 2 or 4

.2 Control Types Supported:

.1 On/Off

.2 On/Off/Dimming

.3 Preset Level Scene Type

.4 On/Off/Dimming/Preset Level for Correlated Color Temperature

.5 Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

.6 Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

.3 Colors: Ivory, White, Light Almond, Gray, Black, Red

.2 Wired Graphic Wall Stations

.1 Device shall surface mount to single-gang switch box.

.2 Device shall have a 3.5", capacitive full color touch screen.

.3 Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.

.4 Device shall enable mobile application control of control zones and scenes through Bluetooth.

.5 Communication shall be over standard low voltage network cabling with RJ-45 connectors.

.6 Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.

.7 Device shall enable configuration of all switches, dimmers, control zones, and lighting preset scenes via password protected setup screens.

.8 Graphic wall stations shall support the following device options:

.1 Number of control zones: Up to 16

.2 Number of scenes: Up to 16

.3 Profile type scene duration: User configurable from 5 minutes to 12 hours

.4 Colors: White, Black

.3 Wired Digital Key Switches

.1 Devices shall recess into single-gang switch box and fit a standard GFI opening.

.2 Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

.3 All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.

.4 Devices shall have LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.

.5 Digital key switches shall support the following device options:

.1 Control Types Supported:

.1 On/Off

.2 On/Off/Dimming

.3 Preset Level Scene Type

.4 Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

.5 Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

.2 Colors: Ivory, White, Light Almond, Stainless Steel

.4 Wired Auxiliary Input / Output (I/O) Devices

.1 Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.

.2 Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

.3 Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:

.1 Contact closure or Pull High input

.1 Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.

.2 0-10V analog input

.1 Input shall be programmable to function as a daylight sensor.

.3 RS-232/RS-485 digital input

.1 Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.

.4 0-10V dimming control output, capable of sinking up to 20mA of current

.1 Output shall be programmable to support all standard sequence of operations supported by system.

.5 Digital control output via EldoLED LEDcode communication

.1 Output shall be programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

.5 Wired Occupancy and Photosensors

.1 Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

.2 Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

.3 For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.

.4 Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.

.5 All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonic technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

.6 System shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.

.7 Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

.8 All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.

.9 Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.

.10 Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).

.11 Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.

.12 Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.

.13 Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

.14 Photosensor and dimming sensor's set-point and dead band shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered and/or modified.

.15 Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

.16 A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

.6 Wired Wall Switch Sensors

.1 Devices shall recess into single-gang switch box and fit a standard GFI opening.

.2 Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

.3 All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.

.4 Devices with mechanical push-buttons shall provide tactile user feedback.

.5 Wall switch sensors shall support the following device options:

.1 User Input Control Types Supported: On/Off or On/Off/Dimming

.2 Occupancy Sensing Technology: PIR only or Dual Tech acoustic

.3 Daylight Sensing Option: Inhibit Photosensor

.4 Colors: Ivory, White, Light Almond, Gray, Black, Red

.7 Wired Digital Relay Packs and Secondary Relays

.1 Relay Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.

.2 Relay Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.

.3 Secondary Relays shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power.

.4 Power Supplies shall provide system power only, but are not required to switch line voltage circuit.

.5 Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).

.6 Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.

.7 Relay Pack programming parameters shall be available and configurable remotely from the software and locally via the device push-button.

.8 Relays Pack shall securely mount through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

.9 When required by local code, Relay Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

.10 Relay/Secondary Relay Packs shall be available with the following options:

.1 Relay Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.

.2 Secondary Relay with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.

.3 Relay and Secondary Relay Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.

.4 Secondary Relay Pack capable of full 16-Amp switching of all normal power lighting load types.

.5 Secondary Relay Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

.6 Secondary Relay Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.

.7 Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.

.8 Secondary Relay Pack capable of louver/damper motor control for skylights.

.9 Secondary Relay Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

.10 Secondary Relay Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BAS).

.11 Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

.8 Control Modules for Low-Voltage Fixtures:

.1 Shall be powered by 120 or 277 VAC and be UL2043 listed.

.2 Shall be remotely configurable using networked lighting control software.

.3 Shall be able to provide UL924-compliant control without the need of an additional, externally-mounted device.

Part 3 Execution

3.1 INSTALLATION REQUIREMENTS

.1 Installation Procedures and Verification

.1 The successful bidder shall review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.

.2 The successful bidder shall install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.

.3 The successful bidder shall be responsible for testing of all low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:

.1 Wire Map (continuity, pin termination, shorts and open connections, etc.)

.2 Length

.3 Insertion Loss

3.2 SYSTEM CABLING REQUIREMENTS

.1 Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

.2 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.

.1 Adjust time delay so that controlled area remains lighted for 15 minutes after occupant leaves area or as indicated on sequence of operation.

.3 Install power packs in accessible areas for future maintenance as indicated on design drawings.

.4 Do not install digital relay and power packs above drywall ceilings.

.5 Install sensors in gym where noted on plan at mid-height of wall.

.6 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per the manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.

.7 Provide written or computer-generated documentation on the commissioning of the system including room by room description including:

.1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.

.2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)

.3 Load Parameters (e.g. blink warning, etc.)

.8 Re-commissioning – After 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

.9 Include the following support service visits to site:

.1 Pre-wiring visit.

.2 ASHRAE functional testing coordination visit.

.3 Final system commissioning visit.

.10 Site Commissioning

.1 Participate in project site commissioning with lighting control system manufacturer representative present. Coordinate project commissioning requirements with commissioning agents per that specification section.

.11 Factory Commissioning

.1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

.2 The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.

.3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

.4 Factory commissioning shall include functional testing and documentation of the control system conforming to the "Functional Testing" requirements included in the current ASHRAE standard. This cost shall be included in the Tender Price.

.12 Cabling Installation

.1 Cabling Contractor is to adhere to all Standards, regulations and documents listed following.

.2 All products installed must meet or exceed all local, provincial and federal building, fire, health, safety and electrical codes.

.3 The responsibility of this sub-contractor is to include but not be limited to:

.4 Supply and installation of data cabling to every digital lighting control device as per manufacturer's recommendations.

.5 Termination of data cabling as per manufacturer's recommendations.

.6 General installation practices shall be as follows:

.1 Supply and install cabling to locations as detailed on floor plan(s). The Cabling Contractor shall use the cabling support system (supplied by others) to distribute the cables throughout the facility. Where the cables leave the cable support system and extend to the termination point they shall use the conduit provided or cable management system. Any horizontal exposed cable must be installed in surface raceways equal to Wiremold Series 500/700.

.2 All Cables and components to be installed and terminated in accordance with CSA, ANSI/EIA/TIA-568 and its' Amendments as well as UL Guidelines. Particular attention must be given to maintaining the integrity of the pair twists, bend radius and ensuring proper distance is kept from fluorescent light fixtures, electrical cables or any other source of EMI.

.3 The maximum horizontal run length is not to exceed 457 m (1,500').

.4 Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The Cabling Contractor without any additional compensation shall replace damaged cables.

.5 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization, and future moves.

.6 Bush, ream and remove any sharp projections on all conduits prior to installation of communications cables.

.7 When terminating copper cables remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 mm (1/2") for, Enhanced Category 5e.

3.3 SYSTEM SEQUENCE OF OPERATION PROGRAMMING

.1 System shall be programmed according to the Sequence of Operation as listed on design drawings.

.2 Include intended Sequence of Operation programming with system shop drawings for review and approval.

3.4 SYSTEM STARTUP

.1 Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed.

.1 For CAT5e wired devices, low voltage network cable testing shall be performed prior to system startup.

.2 System start-up and programming shall include:

.1 Verifying operational communication to all system devices.

.2 Programming the network devices into functional control zones to meet the required sequence of operation.

.3 Programming and verifying all sequence of operations.

.3 Manufacturer shall be capable of on-site or remote startup and programming.

.4 Manufacturer shall be capable of participating in on-site project commissioning.

.5 Lighting controls Manufacturer to include for the following visits to site:

.1 Pre-wiring visit.

.2 System setup and BAS integration visit.

.3 ASHRAE functional testing coordination visit.

.4 System commissioning visit.

3.5 PROJECT TURNOVER

.1 System Documentation

.1 Submit software database file with desired device labels and notes completed. Changes to this file will not be made by the factory.

.2 Installing contractor to grant access to the owner for the programming database, if requested.

.2 Owner Training

.1 Provisions for onsite training for owner and designated attendees to be included in submittal package.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CAN/ULC-S524 (latest edition), Installation of Fire Alarm Systems.

.2 ULC-S525 (latest edition), Audible Signal Appliances for Fire Alarm Systems.

.3 CAN/ULC-S526 (latest edition), Visual Signal Appliances, Fire Alarm.

.4 CAN/ULC-S527 (latest edition), Control Units, Fire Alarm.

.5 CAN/ULC-S528 (latest edition), Manual Pull Stations.

.6 CAN/ULC-S529 (latest edition), Smoke Detectors.

.7 CAN/ULC-S530 (latest edition), Heat Actuated Fire Detectors, Fire Alarm.

.8 CAN/ULC-S531 (latest edition), Smoke Alarms.

.9 CAN/ULC-S536 (latest edition), Inspection and Testing of Fire Alarm Systems.

.10 CAN/ULC-S537 (latest edition), Verification of Fire Alarm Systems.

.11 CAN/ULC-S552 (latest edition), Inspection, Testing and Maintenance of Smoke Alarms.

.12 CAN/ULC-S553 (latest edition), Installation of Smoke Alarms.

.13 OBC-2024, Ontario Building Code Compendium.

1.2 DESCRIPTION OF SYSTEM

.1 System includes:

.1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.

.2 Trouble signal devices.

.3 Power supply facilities.

.4 Addressable manual alarm stations.

.5 Addressable and conventional automatic alarm initiating devices.

.6 Audible and visual signal devices.

.7 End-of-line devices.

.8 Annunciators.

.9 Ancillary devices.

.10 Interface and zone modules.

.11 Remote trouble indicator.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

.1 This system is subject to review by local building department officials, local fire department officials. **Therefore, submission of verification certificate and field technician device verification sheets is required prior to inspection by these officials. Schedule accordingly.**

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Electrical General Requirements Section.

.2 Include:

.1 Layout of equipment.

.2 Zoning.

.3 Complete wiring diagram.

1.5 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Electrical General Requirements Section.

.2 Include:

.1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Technical data - illustrated parts lists with parts catalogue numbers.

.3 Copy of approved shop drawings.

.4 List of recommended spare parts for system.

1.6 MAINTENANCE MATERIALS

.1 Include:

.1 10% spare glass rods for total number of manual pull box stations if applicable.

1.7 TRAINING

.1 Arrange and pay for on-site demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system. **Obtain written receipt of training session and include in maintenance manual.**

1.8 SYSTEM OPERATION

.1 The system shall be configured for single stage operation as outlined on the design drawings. Refer to Fire Alarm Sequence of Operation for specific fire alarm sequence functions which generally include the following:

.1 Activation of audible and visual signal devices.

.2 Cause alarm and supervisory zone of alarm device to be indicated on control panel and remote annunciator(s).

.3 Cause system trouble indications.

.4 Activate auxiliary functions.

.5 Transmit signal to fire department via monitoring station.

.6 Log the alarm in the historical alarm log file.

.7 System silence parameters.

.8 System reset parameters.

1.9 PERFORMANCE CRITERIA

.1 These specifications describe the minimum functional requirements for an electronically supervised, microprocessor based, fully integrated system. The initial installation shall include all the necessary electronic hardware, software and memory for a completely operable system in accordance with these specifications.

1.10 QUALITY ASSURANCE

.1 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by the Underwriter's Laboratories of Canada and shall bear the "U.L.C." label.

.2 Each and all items of the fire alarm system shall be covered by a one year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.

.3 All control equipment must have Transient Protection Devices to comply with U.L.C. requirements.

Part 2 Products

2.1 GENERAL

.1 The fire alarm system shall be an addressable, single stage, zoned, non-coded, indicating, fully integrated fire alarm.

.2 The fire alarm control panel shall allow for loading or editing of special instructions and operating sequences as required. The system shall be capable of on site programming to accommodate expansion, and changes required by local codes. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.

.3 The ability to selectively program input/output control functions based on ANDing, ORing, NOTing, Timing and Special Coded Operations is also to be incorporated in the resident software programming of the system.

.4 The system shall have the ability to manually disable and enable any device/circuit individually for maintenance or testing purposes.

.5 It shall be possible to reprogram selected or all smoke detector initiating zones for alarm verification.

.6 It shall be possible to program an adjustable time delay circuit for each waterflow initiating circuit to prevent false alarms that may be caused by erroneous pressure surges in the sprinkler system.

.7 All on site programming changes to the fire alarm system shall be password protected.

.8 Wiring to any remote annunciator shall be supervised for open and ground conditions. A separate annunciator trouble indicator must be provided at the control panel, which shall illuminate and an audible trouble signal shall sound at the control panel upon the detection of an open or ground condition.

.9 All Control Panels and Remote Annunciator Cabinets are to be properly grounded to building ground. Conduit ground will not be acceptable. The green coloured grounding loop shall be a minimum #14 AWG insulated copper conductor run in conduit. The ground loop shall be connected to building water supply to the line side of the water meter. Ground wire must not be run in the same conduit as the Fire Alarm wiring.

2.2 POWER REQUIREMENTS

.1 The control panels shall receive 120 VAC power via a dedicated overcurrent protected circuit. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel and the remote annunciator. A green `Power On' LED shall be displayed continuously while incoming power is present.

.2 Control Panel output power supply shall have the following operating characteristics:

.1 Rated for five Amps continuous duty

.2 24 VDC filtered and regulated

.3 Power limited with a range of 20.4 VDC to 32 VDC.

.4 Automatic "Brownout" transfer to standby batteries when supply voltage falls to 102 VAC

.3 The system shall be provided with sufficient standby capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four hours with two hours of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

.4 The system batteries shall be supervised so that a low battery condition or disconnection of the batteries shall be audibly and visually annunciated at the control panel.

.5 Battery charger shall have the following operating characteristics:

.1 Ability to charge a range up to 33 AH to 70% of their capacity within 12 hours.

.2 Compatible with either lead acid or nicad batteries.

.6 All circuits requiring system operating power shall be individually fused at the control panel.

.7 The system shall be modular in design to allow future expansion with a minimum of hardware additions and system interruptions.

2.3 FIRE ALARM CONTROL PANEL

.1 The fire alarm control panel construction shall be modular in design with solid state microprocessor based electronics. An 80 character Liquid Crystal Display shall indicate alarms, supervisory service conditions and any troubles. The panel shall include but not be limited to the following:

- .1 80 character LCD display
- .2 Local Energy, Shunt Master Box, or Reverse Polarity Remote Station Connection
- .3 Form C Trouble Contact
- .4 Earth Ground Supervision Circuit
- .5 Basic 8 A power supply
- .6 Automatic Battery Charger
- .7 Standby Batteries
- .8 Resident non-volatile programmable operating system memory for all operating requirements.
- .9 Five Programmable Multi-Function keys with status LED's
- .10 Red Alarm LED and Acknowledge Button
- .11 Yellow Supervisory Service LED and Acknowledge Button
- .12 Yellow Trouble LED and Acknowledge Button
- .13 Green Power on LED
- .14 Alarm/Signal Silence Button
- .15 System Reset Button
- .16 Operator Interface Keypad for Manual Control and System Information Access
- .17 Addressable Interface Control Card
- .18 Supervised Annunciator Circuit

.2 The control Panel shall be capable of chronologically logging and storing 300 events in an alarm log and 300 events in a trouble log. The historical logs shall be stored in the CPU's memory and shall be protected by a lithium battery that is supervised for a low battery condition. Each recorded event shall include the time and date of that event's occurrence. The alarm log file must be separate from the trouble log file. It shall be possible for the user to generate a report of both logs upon request.

.3 All auxiliary manual controls shall be supervised so that all switches must be returned to the normal automatic position to clear system trouble.

.4 Signal Circuits shall be independently supervised and fused such that a fault on one circuit shall not affect the operation of any of the other circuits. All signal circuits shall be configured as follows:

- .1 Class “B” wiring, current limited.
- .2 Rated at two Amps of continuous power.
- .3 Capable of powering polarised 24 VDC audible and visual signalling appliances.

.5 Provide dry contact auxiliary control circuits as follows:

- .1 Central Station alarm output.

.2 Central Station trouble output.

.3 SPDT Form C relays fused at 2 A @ 24 VDC.

.6 System Expansion Modules connected by ribbon cables shall be supervised for module placement. Should a module become disconnected the system trouble indicator must illuminate and audible trouble signal must sound.

.7 The Fire Alarm Control Panel shall be capable of supporting RS-232-C I/O ports. CPU data output to the I/O ports shall be in a parallel ASCII format at field adjustable baud rates of 220, 300, 1200, 2400 and 4800.

.8 A walk test feature must be provided.

.9 All system controls shall be housed in a surface wall mounted steel cabinets. Finish shall be according to the manufacturer's standards.

.10 All modules shall be secured behind hinged locked door with a full viewing tempered plastic window. The hinged locked doors shall give access to all the operating controls but shall not expose live connections.

.11 All internal wiring, control circuits, connections and terminals shall only be accessible behind a removable metal retainer plate.

.12 All Cabinets are to be properly grounded to building ground. Conduit ground will not be acceptable.

.13 The system must provide communication with addressable initiating devices. All of these devices will be annunciated on the control panel’s main LCD display. Annunciation shall include the following conditions for each point:

.1 40 Character Zone/Device Location

.2 Type of Device

.3 Detector Status (Normal/Alarm/Trouble)

.4 Device Missing/Failed

.14 The communication format must be a completely digital poll/response protocol to allow tapping of the circuit wiring. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission portion of the protocol.

.15 Each addressable device must be uniquely identified by an address code entered on each device base at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact.

.16 It shall be possible for the owner’s representative to change a smoke detector without any special tools or programming.

.17 The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions. Systems, which cannot support 100% of their point capacity in alarm simultaneously, cannot assure appropriate system response and are not acceptable.

.18 **The appropriate quantity of isolator modules shall be installed so that a wiring fault (short, open or ground) within one floor area shall not prevent the normal operation of other addressable devices on other floor areas.**

.19 The system shall maintain the sensitivity level set, for each sensor, over time by automatically compensating for environmental factors such as dust and dirt accumulations in a smoke sensor's chamber. The smoke sensor shall be a smoke density measuring device having no self-contained set-point. **The control panel shall determine the alarm decision for each sensor.**

.20 The system shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches a predetermined value a `Dirty Sensor' trouble condition shall be audibly and visually indicated at the control panel for the individual sensor.

.21 All data transmissions, **including the analogue value**, between the smoke sensors and the control panel shall be digitally transmitted and incorporate parity and checksum digital data checks of each transmission.

.22 An operator from the control panel, having a proper access level, shall have the ability to:

.1 Manually access and print the following information for each sensor in a report format that can be easily understood by the user:

.1 Primary Status

.2 Device Type

.3 Present Average Value

.4 Present Sensitivity Selected

.5 Highest Peak Detection Values

.6 Sensor Chamber Status (Normal, Almost Dirty, Dirty, Excessively Dirty)

.2 Manually control the following of each sensor:

.1 Clear Peak Detection Values

.2 Enable or Disable the Point

.3 Clear Verification Tally

.4 Control a Sensor's Relay Driver Output

.23 It shall be possible to program the control panel to **automatically** change the sensitivity settings of each sensor based on **time-of-day** and **day-of-week**.

2.4 ADDRESSABLE MANUAL ALARM STATIONS

.1 Manual alarm stations shall be addressable, single action, non-coded, semi-flush mounted type. Pull stations shall be break-glass style. Contacts are to activate when the handle is pulled down.

.2 Addressable pull station electronics shall be mounted to the back plate of the station. The station's address will be set at the time of installation. Device addressing shall be accomplished by either an electrical or mechanical means.

.3 Where noted on drawings, stations are to be equipped with tamperproof guard equal to Stopper II Cat. # STI-1100.

2.5 CONVENTIONAL MANUAL ALARM STATIONS

.1 Manual alarm stations: pull lever, style, wall mounted semi-flush type, non-coded single pole normally open contact for single stage, English signage.

2.6 INTELLIGENT DETECTORS-GENERAL OPERATION

.1 Addressable devices shall use simple to install and maintain decade, numbered 0 to 9, address switches. Detectors that have expanded addressing will have decade switch numbered from 0 to 15 for the most significant digit to allow detector addressing from 1 to 250.

.2 Device addressing shall be accomplished by either an electrical or mechanical means.

.3 Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel signalling line circuits.

.4 Addressable smoke detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

.5 The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.

.6 Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.

.7 The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.

.8 The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

.9 Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).

.10 Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

.11 Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

.12 Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

.13 The sensors shall be of a low profile design and ULC listed for both ceiling and wall mount applications.

.14 Automatic smoke sensors shall be equipped with a dust cover, which shall be removed at the time of verification to prevent dust and dirt entering the smoke chamber during construction.

.15 A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

2.7 INTELLIGENT MULTI-DETECTOR

.1 The intelligent multi-detector shall be an addressable device, which is designed to monitor photoelectric, ionization, and thermal technologies in a single sensing device. This detector shall utilize advanced electronics which react to smaller products of combustion found in fast flaming fires (ionization), slow smouldering fires (photoelectric), and heat (thermal) all within a single sensing device.

.2 The multi-detector shall include two bicolor LEDs, which flash green in normal operation and turn on steady red in alarm.

.3 Detectors are to be provided with relay base where noted on the drawings.

.4 Separately mounted photoelectric ionization and heat detectors in the same location are not acceptable alternatives.

2.8 FIXED TEMPERATURE HEAT DETECTOR

.1 These heat detectors shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the/ time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. The heat detector shall have a nominal alarm point rating of 57ºC (1 35ºF). The heat detector shall be rated for ceiling installation at a minimum of 21.3m (70') centres and be suitable for wall mount applications.

2.9 FIXED TEMPERATURE / RATE OF RISE HEAT DETECTOR

.1 These heat detectors shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm, The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 57ºC (135ºF) and a rate-of-rise alarm point of 9ºC (15ºF) per minute. The heat detector shall be rated for ceiling installation at a minimum of 21.3m (70') centres and be suitable for wall mount applications.

2.10 PHOTOELECTRIC SMOKE DETECTOR

.1 The intelligent photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging, and humidity. The photo detector shall be rated for ceiling installation at a minimum of Soft (Olin) centres and be suitable for wall mount applications.

.2 The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment:

.1 Temperature: 0ºC to 49ºC (32ºF to 120ºF)

.2 Humidity: 0-93% RH, non-condensing

.3 Elevation: no limit

.3 Detectors are to be provided with relay base where noted on the drawings.

2.11 STANDARD DETECTOR MOUNTING BASES

.1 Provide standard detector mounting bases suitable for mounting on North American 1-gang, 85 mm (3 ½ ") or 100 mm (4") octagon box and 100 mm (4") square box. The base shall, contain no electronics, support all detector types and have the following minimum requirements:

.1 Removal of the respective detector shall not affect communications with other detectors.

.2 Terminal connections shall be made on the room side of the base. Bases which must be removed to gain access to the terminals shall not be acceptable.

2.12 INTELLIGENT DUCT SMOKE DETECTOR

.1 The smoke detector housing shall accommodate an intelligent photoelectric detector (as noted above) that provides continuous analog monitoring and alarm verification from the panel.

.2 When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

.3 Duct smoke detector sensor assemblies shall be complete with duct housing, photoelectric smoke detector, and sampling tubes as required. The duct-housing base shall come complete with an auxiliary set of form C dry contacts rated at 120 VAC, 3 Amps.

.4 The system shall automatically indicate when an individual duct sensor needs cleaning.

2.13 CONVENTIONAL AUTOMATIC ALARM INITIATING DEVICES

.1 Thermal fire detectors: fixed temperature, non-restorable, rated 57°C (135ºF) or 88°C (194ºF) as indicated.

.2 Thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57°C (135ºF) or 88°C (194ºF), rate of rise 8.3°C (15ºF) per minute.

.3 Smoke detector: ceiling mounted, photo electric type, visual alarm indicator, complete with relay base where noted.

.4 Smoke detector: photo electric type air duct type with sampling tubes with protective housing.

.1 Plug-in type with fixed base.

.2 Wire-in base assembly with integral red alarm LED, and terminals for remote alarm LED.

2.14 AUDIBLE/VISUAL SIGNAL DEVICES

.1 150 mm (6") Bells: surface mounted bell, vibration type 24Vdc, 150 mm (6"), 92dBA rating at 3 m (10'), red finish, FM and ULC listed.

.2 250 mm (10") Bells: surface mounted bell, vibration type 24Vdc, 250 mm (10"),94dBA rating at 3 m (10'), red finish, FM and ULC listed.

.3 Horn: flush mounted temporal horn, 24Vdc operation, 94 dBA rating at 3 m (10'), red finish, FM and ULC listed.

.4 Mini Horns: flush mounted temporal mini horn, 24Vdc operation, selectable HIGH/LOW setting 94.5 dBA (high)/89.8 dBA (low) at 3 m (10'), white or red coverplate, FM and ULC listed. Suitable for mounting on a single gang box.

.5 Speakers/strobes: Ceiling surface mounted speaker/strobe devices, white finish complete with “FIRE” marking, speaker to be 25 V RMS complete with selectable wattages (¼, ½, 1, or 2 watt), strobe to be 15 to 95 cd and 16 – 33 VDC, FM and ULC listed.

.6 Speakers/Strobes: Recessed wall mounted speaker or speaker/strobe devices, red finish complete with “FIRE” marking, speaker to be 25 V RMS complete with selectable wattages (¼, ½, 1, or 2 watt), strobe to be selectable 15 to 110 cd and 16 – 33 VDC, FM and ULC listed.

.7 Strobe: semi-recessed, 24Vdc operation, complete with selectable 15/30/75/110 candela output (unless otherwise noted set at 75 cd), synchronized strobe, red finish, FM and ULC listed. Suitable for mounting on a single gang box.

.8 Mini Horn/Strobe: flush mounted temporal combination mini horn/strobe, 24 Vdc operation, selectable HIGH/LOW setting 94.5 dBA (high)/89.8 dBA (low) at 3 m (10') selectable 15/30/75/110 candela output (unless otherwise noted set at 75 cd), synchronized strobe white or red coverplate, FM and ULC listed. Suitable for mounting on a single gang box.

NOTES:

.1 Signal devices with integral strobe lights in high abuse areas (i.e. gymnasium, change rooms, etc.) must be provided with protective wireguards.

.2 Any surface mounted signal devices must be provided with suitable backboxes supplied by the manufacturer.

.3 Provide synchronization modules to suit signal devices (if required by manufacturer).

.4 Set signal devices in classrooms to LOW setting.

2.15 END OF LINE RESISTORS

.1 End-of-line resistors for signalling circuits shall be sized to ensure the correct supervisory current flows in each circuit.

.2 End-of-line resistors shall be mounted on a stainless steel plate for mounting on a standard single gang box and bear the ULC label.

2.16 REMOTE ANNUNCIATOR PANELS

.1 Each remote panel in the installed system shall include remote control display annunciators. These annunciators shall have integral membrane style, tactile push-button control switches for the control of system functions, and LED-s with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events.

.2 The remote control display annunciators shall provide the system with individual zone and device annunciation.

.3 Annunciator must be keyed similar to control panel.

2.17 GRAPHIC DISPLAY (PASSIVE)

.1 Colour graphic layout of facility showing all zones as specified/indicated. Zones shall each have descriptions and zone number indications per fire alarm zone schedule.

.2 Display is to be found behind Plexiglas, approximate size: 500 mm x 500 mm (20" x 20"). Adjust frame size of graphic accordingly to clearly display building zones and zone labels clearly. Max frame size shall be coordinated with available wall space at indicated mounting location. Electrical trade to confirm final graphic location on site.

.3 Finish frame to architects' direction.

2.18 ANCILLARY DEVICES

.1 Relay unit to initiate fan shutdown on mechanical units noted on riser.

.2 Relay unit to facilitate elevator recall functions as indicated.

2.19 INTELLIGENT MODULES – GENERAL OPERATION

.1 The modules shall have a minimum of 2 diagnostic LED's mounted behind a finished coverplate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes, which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:

.1 Temperature: 0ºC to 49ºC (32ºF to 120ºF).

.2 Humidity: 0-93% RH, non-condensing.

2.20 MONITOR MODULE

.1 The monitor modules shall have the following operating characteristics:

A flashing LED indicates that the module is in communication with the control panel. The LED latches steady on alarm (subject to current limitations on the loop).

.2 The monitor modules shall have the following features:

Nominal operating voltage:	15 to 32 VDC.
Maximum current draw:	5.1 mA (LED on)
Average operating current:	400 uA (LED flashing)
EOL resistance:	47K ohms.
Temperature range:	0°C to 49°C (32°F to 120°F)
Humidity range:	10% to 93% noncondensing
Dimensions:	114.3 mm (4.5") high x 101.6 mm (4") wide x 31.75 mm (1.25") deep. Mounts to a 101.6 mm (4") square x 53.975 mm (2.1/8") deep box.

2.21 ISOLATOR MODULE

.1 Fault isolator modules shall be provide to automatically isolate wire-to-wire short circuits on an SLC loop. The fault isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop. If a wire-to wire short occurs, the fault isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the fault isolator module shall automatically reconnect the isolated section of the SLC loop. The fault isolator module shall not require any address-setting, and its' operations shall be totally automatic. It shall not be necessary to replace or reset a fault isolator module after its normal operation. The fault isolator module shall mount in a standard 10.16 cm (4") deep electrical box, in a surface-mounted backbox, or in the fire alarm control panel. It shall provide a single LED which shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.22 CONTROL MODULE

.1 Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

.2 The control module NACs may be wired for Style Z or Style Y (Class A/B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% or all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

.3 The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 Amps at 30 VDC.

2.23 DOOR HOLD OPEN DEVICES

.1 Units to be complete with the following features:

.1 Wall mounted style.

.2 Long life electromagnet.

.3 Low current operation.

.4 Completely silent operation.

.5 25 lbf (111N) minimum holding force.

.6 Adjustable swivel contact plate.

.7 Brushed zinc finish.

.8 Maintenance free operation.

.9 Water resistant design.

.10 ULC, CSA, and FM approved.

2.24 SPRINKLER AND SUPERVISED VALVE CONNECTIONS

.1 Sprinkler and standpipe system contacts shall be provided by the mechanical/sprinkler contractor but connected into the fire alarm system by this Division.

2.25 REMOTE TROUBLE INDICATOR

.1 A system remote trouble indicator where noted on the drawings shall be provided complete with the following features:

.1 Flush mounted in a double gang box.

.2 Trouble LED.

.3 Trouble buzzer.

2.26 SMOKE ALARMS 120V HARDWIRED

.1 Photoelectric sensor 3-in-1 smoke alarm unit c/w LED strobe and CO alarm.

.2 Integral 177 candela strobe with ability to synchronize to other interconnected strobe alarms during an alarm event.

.3 120V hardwired with 10-year sealed battery backup (sealed 3V lithium battery on smoke and CO alarm portion only).

.4 Low profile construction.

.5 Auxiliary relay for use with smart building systems as specified.

2.27 SYSTEM WIRING

.1 The system wiring must be FSA rated in conformance with the Electrical Safety Code to suit the type of installation.

.2 Wiring shall be minimum #18 AWG twisted shielded pair in conduit. “Securex 2” armoured cable will be permitted to be used for “drops” to devices on accessible ceilings.

.3 As indicated on system riser diagram initiating device wiring shall be run in a loop with a home run from the last device to the control panel (Class 'A' configuration). Wiring from the "loop" module to conventional devices must be supervised, run in conduit, and conform to the standards of the Electrical Safety Code.

.4 Signal wiring is to be cross connected in a class 'B' configuration.

.5 Install isolator modules and end of line resistors in service rooms no higher than 2.4 M AFF. Provide location of these devices at the time of shop drawing submission.

.6 **These are the basic wiring requirements for system operation. Prior to tender close manufacturer and contractor are to confirm all necessary wiring specifications and requirements.**

2.28 APPROVED EQUIPMENT

DEVICE	**NOTIFIER**	**EDWARDS**	**SIMPLEX**	**MIRCOM**
Control Panel				
	NFS2-3030 1-10 loops 318 add/loop	EST 4 or EST 3X	4010-ES -2 loop -250 add	FX-4000 Series
	NFS2 640 2 loops 636 add	EST 3X or I/O Series		
	NFS 320C 1 loop 318 add	I/O Series	4100-ES	
Intelligent Devices				
Manual Alarm Stations 1-Stage	NBG 12LX	SIGA-270	4099-9001	MS-401AD
Addressable Multi-Sensor	FSP-851TA	SIGA2-PS		MIX-2251TB
Addressable Base	B710LPA	SIGA-SB	4098-9792	B21OLPA
Addressable Base c/w Relay	B224RBA	SIGA-RB	4098-9791 c/w 2098-9737	B224RBA
Heat Sensor	FST-851RA	SIGA2-HRS or SIGA2-HFS	4098-9733	MIX-5251RBA Series

Smoke Detectors	FSI-851A	SIGA-PS	4098-9714	MIX-2251BA
Duct Type Smoke Detector (c/w Air Sampling Tubes)	FSD-751PA + ST-X	SIGA-SD c/w SIGA-PS	4098-9755 and 4098-9714	DNRA (Housing) MIX-2251BRA (Detector) DST (Tubes)
Monitor Module	FMM-1A	SIGA-CT Series	ZAM-Monitor 4090-9001	MIX-M500MA
Control Module	FCM-1 or FRM-1	SIGA-CR	ZAM-Control 4090-9002	MIX-M500RA
Isolator Module	ISO-XA	SIGA-IM	4090-9116	M500XA
Annunciator	ACM-32 AEM-32 ACM-32AY	EST3-6ANN	4603-9101 (GEO-7000 Series flush enclosure)	RAX-LCD RAM-1032TZ/RAM-1016TZ RAX-1048
Conventional and Auxiliary Devices				
Manual Alarm Stations	MPS-950 Series	270 Series	2099-9754	MS-400 Series
Thermal Detectors	CR Series	280-PL Series	4255-51/54	5600 Series
Smoke Alarms 3-in-1 (120V hardwired) complete with Strobe, 10 Year Sealed Battery and CO Alarm	KIDDE Cat. # P4010ACLEDSCOCA	KIDDE Cat. # P4010ACLEDSCOCA	KIDDE Cat. # P4010ACLEDSCOCA	KIDDE Cat. # P4010ACLEDSCOCA

Carbon Monoxide Alarm 120V with Battery Backup	Kidde 900-0128-001 (Pro Series CO)	Kidde 900-0128-001 (Pro Series CO)	Kidde 900-0128-001 (Pro Series CO)	Kidde 900-0128-001 (Pro Series CO)
Smoke Detectors (System Type)	C2W-BA Series	C2M-PDC	4098-9601C 4098-9788C	C2W-BA
Smoke Detectors (System Type c/w Relay Base)	C2WR-BA	C2M-PDHRC	4098-9601C 4098-9682C	C2WTR-BA
Duct type Smoke Detector (c/w Air Sampling Tubes.)	DH100PA / ST-X	6260A-CU/ EC30DU-3	4098-9685C	D2A (Housing) 2151A (Detector) DSTSeries (Tubes)
Horn	Spectralert Series	757 Series	True Alert Series	FH-340
Mini Horn	MHRA (System Sensor)	Genesis G1R-HD	4901-9858	FH-340R
Door Holder	FMM Series	1500 Series	2088 Series	DH Series
Mini Horn complete with strobe	P2RA (System Sensor)	Genesis G1R-HDVM	4906-9127	FHS-340R
Low Frequency Mini Horn complete with strobe (residential suites)	Equal	Genesis G4LFV	Equal	Equal
Strobe	SRA (System Sensor)	G1R-VM	4906-9101	FS-340R
Remote Trouble Indicator	RTB	RTU	RT1-1C	RTI-1

Part 3 Execution

3.1 INSTALLATION

.1 The entire system shall be installed in accordance with CAN/ULC-S524 (latest edition) and approved manufacturers manuals and wiring diagrams. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation, All wiring shall be of the type recommended by the Electrical Safety Code, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated conduit throughout.

.2 Install main control panel and connect to ac power supply.

.3 Locate and install manual alarm stations and connect to alarm circuit wiring.

.4 Locate and install detectors and connect to alarm circuit wiring. **Do not mount detectors within 1 m (39") of air outlets.** Maintain at least 600 mm (24") radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

.5 Connect alarm circuits to main control panel.

.6 Locate and install signal devices and connect to signalling circuits.

.7 Connect signalling circuits to main control panel.

.8 Install end-of-line devices at end of applicable alarm and signalling circuits.

.9 Install remote annunciator panels and connect to annunciator circuit wiring.

.10 Locate and install door releasing devices.
Note: Door holders must release by way of local smoke detector and signal from main control panel. Provide additional relays to suit.

.11 Locate and install remote relay units to control fan shut down.

.12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.

.13 Connect fire suppression systems to control panel.

.14 Elevator controllers are to be connected with 4 #14 conductors in conduit from fire alarm control panel to signal elevator recall in the event of a general alarm.

.15 **Connect each combination fire/smoke damper integral detector outputs to individual monitor modules for alarm condition and for AC power to damper assembly trouble condition at the fire alarm panel based on module address.**

.16 Where more than one smoke alarm is installed within a space or dwelling unit, interconnect smoke alarms to each other such that audible signal sounds throughout the space upon activation of any smoke alarm. Smoke alarms are to be interconnected with 3#12 conductors in conduit and connected per manufacturers recommendations.

3.2 PROTECTION

.1 Contractor is to ensure all fire protection system 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. Any detectors that are damaged or dirty shall be replaced at the contractor’s expense.

3.3 FIELD QUALITY CONTROL

.1 The system shall be installed and fully tested under the supervision of trained manufacturer's representative. The system shall be demonstrated to perform all the functions as specified.

3.4 ACCEPTABLE INSTALLER

.1 The fire alarm / life safety system specified herein shall be installed by an Authorized Electrical Contractor who is CFAA certified.

3.5 EXAMINATION

.1 Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm / Life Safety System and all associated components are to be installed shall be made.

.2 Any of these area(s) which are found to be outside the manufacturers' recommended environments for the particular specified products shall be noted on a Site Examination Report which shall be given to the Building Owners Representative, and the Consultant.

.3 Any shorts, opens, or grounds found on existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

3.6 DEMONSTRATION

.1 Each of the intended operations of the installed Fire Alarm / Life Safety System shall be demonstrated to the Building Owners' Representative and the Consultant.

3.7 SYSTEM TEST

.1 Perform tests in accordance with General Electrical Requirements Section and CAN/ULC-S537-(latest edition) Standard for the Verification of Fire Alarm Systems.

.2 Fire alarm system:

.1 Test each device and alarm circuit to ensure noted devices transmit alarm to control panel and actuate general alarm and ancillary devices.

.2 Check annunciator panels to ensure zones are shown correctly.

.3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.

.4 Class A circuits.

.1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each conductor on all circuits for capability of providing alarm signals during ground-fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.5 Class B circuits

.1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.3 The control panel shall continuously perform as automatic self-test routine on each sensor, which will functionally check the sensor electronics and ensure the accuracy of the valves being transmitted to the control panel.

.4 Automatic testing will occur at a rate of one sensor every four minutes.

.5 The sensor's average analogue value is the average of the last 2000 recorded analogue entries of its chamber.

.6 Any sensor that fails this test shall indicate a '**SELF-TEST ABNORMAL'** trouble condition with the sensor's address at the control panel.

.7 The system shall automatically indicate when an individual sensor needs cleaning. When the sensor's average value reaches a predetermined value, a **'DIRTY SENSOR'** trouble condition shall be audibly and visually indicated at the local control panel for that sensor. IF a **'DIRTY SENSOR'** indication is left unattended and its average value increases to a second predetermined value, an **'EXCESSIVELY DIRTY SENSOR'** trouble condition shall be indicated at the local control panel for that sensor. To prevent false alarms, these **'DIRTY'** conditions shall in no way decrease the amount of smoke obscuration necessary to generate an alarm condition.

.8 An operator having a proper access level, shall have the capability to manually access the following information from the control panel:

.1 Primary Status

.2 Device Type

.3 Present Average Value

.4 Present Sensitivity Selected*

.5 Highest Peak Detection Values (HVP)*

.6 Sensor Range (Normal, Dirty, Excessively Dirty)

* Values shall be in 'percent of smoke obscuration' format so that no interpretation is required by the operator.

3.8 AUDIBILITY TESTING

.1 Audibility Testing:

.1 The contractor is to coordinate an audibility test prior to occupancy of the facility. The test is to be performed by the representatives of the fire alarm manufacturer in the presence of the consultant. The test report is to be in chart form indicating:

.1 Project

.2 Date of test

.3 Room name and number

.4 Ambient dB level

.5 Alarm dB level

.6 Name of testing technician

.2 The test results are to be submitted to the consultant for review prior to issuing to owner's representatives and/or authorities having jurisdiction.

3.9 SMOKE ALARM TESTING

.1 Perform tests on smoke alarms in accordance with CAN/ULC-S552-(latest edition) Standard for Inspection, Testing and Maintenance of Smoke Alarms, and in accordance with manufacturer's instructions.

.2 Smoke testing shall be completed for each smoke alarm device installed (not button testing).

.3 Each smoke alarm shall be individually tested. Smoke alarm interconnections shall also be tested such that all connected smoke alarms will sound when any one of the smoke alarms is tested.

.4 At the completion of the project and in the presence of the consultant, test all smoke alarms. On company letterhead, the contractor is to prepare a chart indicating:

.1 Project

.2 Date

.3 Equipment type

.4 Certification of test completion of each individual device

.5 Certification of testing conducted with smoke producing device

.6 Certification of correct operation

.7 Confirmation for all smoke alarms functioning together (integration between multiple smoke alarms in common space).

.8 Actual period of testing (time of day)

3.10 INTEGRATED LIFE SAFETY SYSTEM TESTING

.1 This electrical contractor shall participate in integrated testing of this life safety system in conformance with Electrical General Requirements. Include all associated costs in tender.

3.11 ADDITIONAL INSTALLED FIRE ALARM SYSTEM COMPONENTS

.1 The electrical contractor is to include in their bid the cost to add five (5) additional signaling devices to be installed and verified in locations as directed by the consultant. Note: This installation and verification and subsequent audibility test will be occurring after the initial audibility testing is complete.

.2 The electrical contractor is to include in their bid the cost to add three (3) additional fire detection devices (heat or smoke detectors) to be installed and verified in locations as directed by the consultant.

.3 The electrical contractor is to include in their bid the cost to add three (3) additional fire alarm zones with associated zone modules and including six (6) additional isolation modules to be installed and verified as directed by the consultant.

.4 The electrical contractor is to include in their bid the cost to add five (5) additional fire smoke damper connections and 120V loss of power trouble signal with associated module and including ten (10) additional isolation modules to be installed and verified as directed by the consultant.

END OF SECTION