CRESTWOOD SECONDARY SCHOOL
MECHANICAL UPGRADES - 2021

1885 Sherbrooke Street West, Peterborough, Ontario K2K 0G2

Tender PUR21-067-ITT

KAWARTHA PINE RIDGE DISTRICT SCHOOL BOARD

MECHANICAL SPECIFICATIONS

PROJECT MANUAL VOLUME 2

MOFFET & DUNCAN ARCHITECTS INC.
Prime Consultant

RAVENS ENGINEERING INC.
Structural Engineer

DEI CONSULTING ENGINEERS
Mechanical & Electrical Engineers

END OF SECTION

Part 1 General

1.1 GENERAL PROVISIONS

.1 This section covers items common to all sections of Mechanical 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.

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 mechanical 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 & 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.

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.

.5 Submit a copy of all final certificates in the maintenance manuals.

1.5 DRAWINGS

.1 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.

.2 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.

.3 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 diagramatically, 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.

.4 Install piping and ductwork to clear structural members and any fireproofing. Locate mechanical 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.

.5 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.

.6 Locate all mechanical and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.

.7 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.

.8 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.

.9 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

1.6 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 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 layout drawings, clearly showing fasteners and hangers.

.6 Provide CAD drawings (minimum release AutoCAD 2007) 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 mechanical 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 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 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 Inspection

.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 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 mechanical 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 Mechanical 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 Mechanical 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 Mechanical 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 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.

Mobilization and shop drawings (max. $2000.00)
Demolition
Above grade rough-in plumbing and drainage
Circulation pumps
Heating piping
Refrigerant Piping
Piping Insulation
Ductwork
Duct Insulation
Exterior Insulation Jacketing
Grilles & Diffusers
Fire Stopping
Air Handling Units
Condensing Units
Packaged HVAC Units
Fans & Equipment
Building Automation Systems
Testing Adjusting and Balancing
HVAC system commissioning
Mechanical contractor closeout requirements (min. of 3% but not 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.

1.12 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 30 days after award of Contract.

.2 Provide a complete list of shop drawings to be submitted prior to first submission.

.3 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.

.4 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.

.5 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.

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

.7 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.

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

.9 Shop drawings and product data shall show:

.1 Mounting arrangements.

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

.10 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.

.11 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.

.12 Shop drawings shall be submitted electronically as per the following directions:

.1 Electronic Submissions:

.1 Electronically submitted shop drawings shall be prepared as follows:

.1 Use latest software to generate PDF files of submission sheets.

.2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.

.3 PDF format shall be of sufficient resolution to clearly show the finest detail.

.4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".

.5 Submissions shall contain multiple files according to section names as they appear in Specification.

.6 File names shall include consultant project number and description of shop drawing section submitted.

.7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.

.8 On the shop drawing use an “electronic mark” to indicate what is being provided.

.9 **Each file shall bear an electronic representation of the “company stamp” of the contractor. If not stamped the file submission will not be reviewed.**

.2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.

.3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating “1 of 2” and “2 of 2” in email subject line for the case of two messages.

.4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.

.5 On site provide one copy of the “reviewed” shop drawings in a binder as noted above.

.6 Contractor to print copies of “reviewed” shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

1.13 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 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.

.4 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.

.5 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.

.6 Miscellaneous data to include:

.1 Letter of contractors 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.

.7 Approvals:

.1 Submit 1 copy of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant.

.2 Make changes as required and re-submit as directed by Consultant.

.3 Provide two (2) copies of final operation maintenance manuals, as well as a PDF file of the entire approved manual on a USB stick. Only one USB stick is to be provided containing both the approved manual and As-built drawings.

.8 Additional data:

.1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.14 AS-BUILT DRAWINGS

.1 Site records:

.1 Contractor shall provide 2 sets of reproducible mechanical 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 mechanical systems, control systems and low voltage control wiring.

.2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection at all times.

.2 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.

.2 Identify each drawing in lower right-hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).

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

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

.5 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.

1.15 WARRANTIES

.1 In addition to guarantee specified in General Conditions, guarantee heating, cooling, and plumbing systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.

.2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.

.3 If mechanical 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 mechanical sub-contractor approved by Consultant. Include copy of service/warranty agreement in warranty section of Operation & Maintenance Manual.

.4 Warranty period shall start from date of substantial completion.

1.16 SUBSTANTIAL PERFORMANCE

.1 Complete the following to the satisfaction of the consultant prior to request for submission of substantial performance.

.1 As-built Drawings.

.2 Maintenance Manuals

.3 System Start up

.4 TAB Reports

.5 HVAC System Commissioning

.6 Instructions to Owners

.7 Final Certificates (required prior to consultant's release of conformance letter).

.1 Mandatory TSSA Gas Pressure Test (CSA B149.1)

.2 TSSA Certificate of Authorization for split air conditioning systems ***exceed 5 tons

1.17 OCCUPANCY REQUIREMENTS

.1 The contractor shall provide the following documentation to the consultant 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 TSSA Certificate of Authorization for split air conditioning systems ***exceed 5 tons.

1.18 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'/suppliers' invoice if requested.

1.19 DELIVERY STORAGE & HANDLING

.1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials.

.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.

1.20 ASBESTOS

.1 If asbestos is suspected or identified cease all work in the immediate area in accordance with OHSA and notify consultant.

.2 Each contractor and on site employee of the contractor shall have "asbestos awareness training".

.3 The Contractor shall ensure that employees who may come into contact with asbestos due to the nature of the work that they perform, have received training that enables them to recognize asbestos and that enables them to react in accordance with the

Occupational Health and Safety Act and regulations thereto should contact with asbestos occur during the course of their work.

.4 It is the responsibility of the contractor to review the asbestos book in the building prior to starting any work.

.5 Existing occupied buildings (depending upon their age) may contain asbestos in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain asbestos and shall not be disturbed.

.6 A survey of each building documenting the location and condition of asbestos-containing materials is available for your mandatory review prior to commencing any work on premises.

1.21 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 mechanical 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.

1.22 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.

1.23 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 mechanical 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 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 drainage, waste and vent piping to Ontario Building Code 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 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 Mechanical 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 Mechanical 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.

1.4 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 Domestic water

.4 Plumbing and drainage.

1.5 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.

1.6 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.

1.7 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 mechanical equipment at following heights unless indicated otherwise.

.1	**Hydronic heating elements**	**200 mm (8") to bottom of cabinet**
.2	**Backflow preventors**	**900 – 1200 (3'– 4') to centerline of unit**
.3	Thermostats: Barrier Free (operable)	1200 mm (47.25")
	Non Barrier Free	1500 mm (59")

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

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 mechanical responsibility is indicated in Equipment Schedule on 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 specified in Mechanical Division. Follow Electrical Division for quality of materials and workmanship.

.3 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.

1.11 CONTROL WIRING

.1 Furnish and install all components, devices, and control wiring for all 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, mechanical wiring and installations shall comply with local and national electrical and mechanical 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 mechanical or 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 MOTORS

.1 Provide high efficiency motors for mechanical 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.

1.13 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.

1.14 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 in Floor

.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.

1.15 PIPING AND EQUIPMENT SUPPORTS

.1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Mechanical 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.

1.16 ROOF MOUNTED DUCT SUPPORT

.1 Provide zero penetration duct support on roof where indicated.

.2 Base shall be made of high density polypropylene with UV protection.

.3 Frames shall be galvanized. All fastenings, rods, nuts, washers, etc. shall be stainless steel.

.4 Provide shop drawings as specified. Install to manufacturers recommendations.

.5 Acceptable materials:
Portable pipe hanger
Bigfoot systems
Miro rooftop support
Trikon Systems

1.17 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 material:
Portable pipe hanger
Bigfoot systems
Miro rooftop supports

1.18 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.

1.19 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 cementious or rigid seals around penetrations for pipe, ductwork, or other mechanical items.

.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 Manufacturer:
Minnesota Mining and Manufacturing

.16 Acceptable Alternate Manufacturers to approval of local authority:
Fryesleeve Industries Inc.
General Electric Pensil Firestop Systems
International Protective Coatings Corp.
Rectorseal Corporation (Metacaulk)
Proset Systems
3M
AD Systems
Hilti

.17 Ensure firestop manufacturer representative performs on site inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

1.20 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.

1.21 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, base colour as specified in Mechanical 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.

1.22 SPARE PARTS

.1 Furnish spare parts in accordance with general requirements and as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket set for each heat exchanger.

.4 One glass for each gauge glass.

.5 One set of belts for each type or each size of machinery.

.6 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.

1.23 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.

1.24 ACCESS DOORS

.1 Provide access doors to concealed mechanical 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 Installation:

.1 Locate so that concealed items are accessible.

.2 Locate so that hand or body entry (as applicable) is achieved.

.5 Acceptable materials:
Le Hage
Zurn
Acudor
Nailor Industries Inc.

1.25 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.

1.26 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.

1.27 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.

1.28 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.

1.29 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, 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.

1.31 OWNER SUPPLIED EQUIPMENT

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

1.32 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.

1.33 EXISTING CONCRETE SLAB X-RAY/SCANNING

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

.2 Failure to locate existing piping, conduit rebar etc., shall not relieve this contractor of repair of same prior to installing his service.

.3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

1.1 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.

END OF SECTION

Part 1 General

1.1 GENERAL PROVISIONS

.1 Conform to the General Provisions of General Requirements Section.

.2 This project is one of a retrofit nature in part, and which will require some demolition.

.3 Allow for all remedial work in areas indicated on the drawings and as generally defined in the relevant sections of the specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

.1 Electrical Division.

1.3 SCOPE OF WORK

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

Part 2 Products

2.1 GENERAL

.1 This Division is to liaise with the Owners or Consultant for equipment being removed that may be suitable for reuse to that specified or handed over to the owner.

.2 This Division to take full responsibility for any special tools or equipment required to disassemble or remove material from building.

Part 3 Execution

3.1 GENERAL

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

.2 The general execution of the demolition is to be carried out in a clean and efficient manner.

.3 Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.

.4 All openings or holes created by removal of existing mechanical systems which are not being reused are to be patched with the same material surrounding surfaces.

.5 All new holes and openings to facilitate mechanical systems are to be patched to match surrounding surfaces.

.6 Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.

.7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.

.8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.

.9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.

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

.11 Cap and conceal all redundant and obsolete connections.

.12 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site which the owner does not retain.

.13 Maintain equipment to be retained by owner on site where directed by consultant.

.14 Demolition of all parts of the work must be completed within the confines of the work area and in such a way as the dust produced and risk to injury of will not adversely affect the building users.

.15 Demolished areas of the existing building will remain in their current use in some cases. Demolition in these areas must be kept to the minimum required to complete the work.

.16 Demolition shall take place within areas isolated from all other areas with appropriate hoarding, scaffolding, netting, fencing or other means of security between building users and the work.

.17 Co-ordinate making safe electrical devices, capping plumbing and removal of fixtures prior to commencement of demolition.

.18 All piping and equipment to be removed and/or abandoned shall be drained prior to capping and/or abandoning. Disposal of all liquids shall be to the approval of authority of having jurisdiction and/or provincial regulations.

3.2 EXISTING SYSTEM DRAINAGE

.1 Drain all existing piping and drainage systems including all related equipment as required to facilitate system renovations.

.2 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

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.

1.2 PRODUCT DATA

.1 Submit product data in accordance with general requirements.

.2 Indicate for each item as applicable:

.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 Data to include:

.1 Servicing requirements, including any special requirements, stuffing box packing, lubrication and recommended procedures.

Part 2 Products

2.1 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.

SPEC NOTE: Re 2.2.6. Use monel or inconel when fluorides or caustics are present in the fluid.

.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.

2.2 FLEXIBLE CONNECTION

.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.

2.3 ANCHORS AND GUIDES

.1 Anchors:

.1 Provide as indicated.

.2 Alignment guides:

.1 Provide as indicated.

.2 To accommodate specified thickness of insulation.

.3 Vapour barriers, jackets to remain uninterrupted.

2.4 EXPANSION COMPENSATORS (EXP)

.1 Packless guided construction complete with multi ply stainless steel bellows.

.2 Operating temperature (750°F).

.3 Provide model H3 for steel pipe and model HB for copper pipe.

.4 Material to match piping system.

.5 Acceptable materials:
Senior Flexonics

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 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.

.4 Provide expansion compensators (exp.) on radiation heating element exceeding 3.6 M (12' – 0") in length. Provide one expansion compensators on each length of return piping in cabinet.

3.3 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 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 clocks.
- .4 Syphons.
- .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 materials:
  - .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 materials:

.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 materials:

.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 Heat exchangers.

.2 Water heating and cooling coils.

.3 Water Boilers

.4 Chillers.
.5 Cooling towers.
.6 DHW tanks.
.7 Boiler Room HWS and HWR.
.8 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 water meters.
.8 Inlet and outlet of backflow prevention.
.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 in 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 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 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 ROOF MOUNTED EQUIPMENT

.1 Install as per manufacturers' 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.

2.10 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 materials:

.1 Grinnell
.2 Anvil
.3 Myatt
.4 Taylor

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
.2 Bolt-tightening torques to be to industry standards.
.3 Steel pipes: Install below coupling or shear lugs welded to pipe.
.4 Cast iron pipes: Install below joint.

.4 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

3.2 HANGER SPACING

.1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.

.2 Fire protection: to applicable fire code.

.3 Gas and fuel oil piping: up to NPS 15 mm (1/2"): every 1.8 m (6').

.4 Copper piping: up to NPS 15 mm (1/2"): every 1.5 m (5').

.5 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 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 materials:
Korfund
Vibro-Acoustics
Vibron

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 10 mm (3/8") minimum thick; 50 durometer; maximum loading 350 kPa (50.8 psi).

.2 Type EP2 - rubber waffle or ribbed; 10 mm (3/8") minimum thick; 30 durometer natural rubber; maximum loading 415 kPa (60.2 psi).

.3 Type EP3 - neoprene-steel-neoprene; 10 mm (3/8") minimum thick neoprene bonded to 1.5 mm (16 gauge) steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa (50.8 psi).

.4 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).

.5 Acceptable materials:
Korfund
IAC Acoustics
Vibro-Acoustics
Vibron

2.3 ELASTOMERIC MOUNTS

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

Acceptable materials:
Vibro-Acoustics
Korfund
IAC Acoustics
Vibron

2.4 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.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; leveling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg (2100 lbs) maximum.

.6 Performance: as indicated.

.7 Acceptable materials:
Korfund
IAC Acoustics
Vibron
Vibro-Acoustics

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, molded with rod isolation bushing, which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element with pre-compression washer and nut [with deflection indicator].

.5 Performance as indicated.

.6 Acceptable materials:
Vibron
IAC Acoustics
Korfund
Vibro-Acoustics

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

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

.2 Acceptable materials:
Vibron
IAC Acoustics
Vibro-Acoustics

2.8 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 materials:
Korfund
IAC Acoustics
Vibron
Vibro-Acoustics

2.9 STRUCTURAL BASES

.1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm (96") on smallest dimension, split for field welding on sizes over 2400 mm (96") on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

.2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.

.3 Bases to clear housekeeping pads by 25 mm (1") minimum.

.4 Acceptable materials:
Korfund
IAC Acoustics
Vibron
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 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

.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 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

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

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

.4 Upon completion of this project all references to room names and numbering shall be to the Owner's requirements which may or may 'NOT' be the numbering system used on the drawings. Each contractor shall verify the proper numbering scheme to be used prior to project completion.

.5 All equipment shall be identified in sequence from the existing equipment and "NOT" duplicate numbering of equipment.

2.5 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.

2.6 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
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
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
Condensate	Green	CONDENSATE
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Instrument air	Green	INSTRUMENT AIR
Control air tubing	White	CONTROL AIR
Conduit for low voltage Control wiring	White	CONTROL WIRING___VOLTS

2.7 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.

2.8 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.

2.9 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 contractor.

2.10 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 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.

1.2 QUALIFICATIONS OF TAB AGENCIES

.1 Names of all personnel it is proposed to perform TAB to be submitted to and approved by Consultant within 30 days of start of work.

.2 Provide documentation confirming qualifications, successful experience.

.3 Only the following NEBB (National Environmental Balancing Bureau) TAB contractors may quote:

.1 Air Audit Inc.
110 Turnbull Court, Unit 11
Cambridge, Ontario
N1T 1K6
(519) 740-0871

.2 Air Velocities Control Ltd.
100 Premium Way
Mississauga, Ontario
L5B 1A2
(905) 279-4433

.3 Flowset Balancing Ltd.
431 Willis Dr.
Oakville, Ontario
L6L 4V6
(416) 410-9793

.4 Dynamic Flow Balancing Ltd.
1200 Speers Road, Unit 36
Oakville, Ontario
L6L 4V6
(905) 338-0808

.5 Air Adjustments & Balancing Inc.
P.O. Box 176,
Schomberg, Ontario
L0G 1T0
(416) 254-3004

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average (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.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

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

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

1.6 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.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in the Mechanical Division.

1.8 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.

1.9 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.

1.10 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%.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

.1 Prior to TAB, submit to 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.

1.13 SUBMITTALS

.1 Submit, prior to commencement of TAB:

.1 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 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.

1.15 TAB REPORT

.1 Format to be in accordance with NEBB, AABC, or SMACNA.

.2 TAB report to show all results in SI or imperial units as indicated on plans and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit copy of TAB Report to consultant for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 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.

1.17 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.

1.18 COMPLETION OF TAB

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

1.19 EXHAUST FAN MEASUREMENT

.1 Upon award of tender contractor shall measure the exhaust fans identified in the schedule and provide the mechanical consultant data of the existing balancing.

.2 Review specified standards and report to Consultant in writing all proposed procedures which vary from standard.

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 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 [during [winter] [summer] design conditions] [at all times].

.2 TAB procedures:

Positive	Negative
Corridors	Washrooms
Cafeteria	Cafeteria Kitchen
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 Provide duct testing as specified.

.6 Provide AHU testing as specified.

.7 Provide plenum testing as specified.

.8 Changing of air handling equipment sheave and belts as required for specified air flow sheaves and belts supplied by unit manufacturer. Retest equipment after sheave change.

END OF SECTION

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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 Record 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
- Commission Consultant performance testing
- Commissioning meetings
- Operating and maintenance manuals
- Training
- Systems Demonstration and turnover
- Testing forms
- Warranties

3.2 SHOP DRAWINGS AND RECORD DRAWINGS

.1 Conform to General Requirements Section for shop drawings and record 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 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

3.9 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:

- Roof Mounted Condensing Units
- Pumps
- Air Handling Units
- 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.

3.10 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

3.11 OPERATION AND MAINTENANCE MANUAL

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

3.12 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
The Mechanical System	4 hours

.7 The minimum training for the BAS shall be as specified in Section 25 40 14. 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.

3.13 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
- 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 allocated a minimum value equal to $5,000.00.

.2 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.2 Canadian General Standards Board (CGSB)

.1 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.2 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.3 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulating Pipes, Vessels and Round Ducts.

.3 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.4 American Society for Testing and Materials (ASTM)

.1 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.2 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.

.3 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.

.4 ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.5 ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.6 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): National 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.

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 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.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre as specified 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 C 335.

.3 Type A-1: Rigid moulded mineral fibre 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.

.4 Materials:

.1 All materials must be supplied by the same manufacturer.

.2 Acceptable Materials:
Fibreglass Canada
Knauf
Manson
Pittsburgh Corning

2.3 INSULATION SECUREMENT

.1 Tape: Self-adhesive, aluminum, reinforced, 50 mm (2") wide minimum.

.2 Contact adhesive: Quick setting.

.3 Canvas adhesive: Washable.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 To ASTM C553.

.2 Hydraulic setting or Air drying on mineral wool, to ASTM C 449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: white.

.3 Minimum service temperatures: -20°C (-4°F).

.4 Maximum service temperature: 65°C (150°F).

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.2 Canvas:

.1 220 g/m^2 (0.0451 lb/ft^2) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

2.8 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 National 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.

3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.

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

.3 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")
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	CANVAS	PVC
Exposed in mech. rooms	CANVAS	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 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 BURIED SANITARY PIPING

.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.

2.2 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.

2.3 CAST IRON PIPING AND FITTINGS

.1 Above 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).

2.4 VENT FLASHINGS

.1 Thaler or equal 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.

.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.

.11 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.

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

.4 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.

.5 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.

.6 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 Do not terminate vents within 3600 mm of any building intake and/or exhaust opening.

.4 Provide copper vent piping through roof as per detail.

.7 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.

.8 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.

.9 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 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).

2.3 FORCED MAINS

.1 Above and below ground sewage pump discharge, size as indicated, type ‘L’ copper to ASTMB88M.

.2 Cast copper, solder fitting to ANSI B16.18.

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

Part 3 Execution

3.1 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 ANSI Z21.10.1/CSA 4.1, Gas Water Heaters Volume I, Storage Water Heaters with Inputs Ratings of 75,000 Btuh, or less.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with general requirements.

.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 WEEPING TILE SUMP AND SIMPLEX PUMP

.1 Retrofit existing basin to accept new pump & controls. Provide motor suitable plug into a receptacle with 20’ of cable.

.2 Pump shall be of the centrifugal type and submersible type motor. The unit shall be capable of 2" solid capacity for normal grey water and 2" discharge pipe.

.3 Pump shall have a capacity of 20 GPM at a total head of 16 feet.

.4 Pump Motor:

.1 Pump motor shall be of the submersible type rated 4/10 horsepower at 3450 RPM. Motor shall be for 60 Hz., three phase, 120 volts (120/1/60). Motor shall be capacitor start, capacitor run type for high starting torque.

.2 Starter winding shall be of the open type with Class F insulation, good for 155°C (311°F) maximum operating temperature. Winding housing shall be filled with a clean, high dielectric oil that lubricates bearings and seals and transfers heat from windings and rotor to outer shell. Air-filled motors which do not have the superior heat dissipating capabilities of oil-filled motors shall not be considered equal.

.3 Motor shall have two heavy-duty ball bearings to support pump shaft and take radial and thrust loads. Ball bearings shall be designed for 50,000 hours B-10 life. Stator shall be bolted to seal plate for easy motor replacement.

.4 The motor shall have a heat sensor thermostat and overload attached to the top end of the motor windings to stop the motor if the motor winding temperature reaches 200°F. The high temperature shutoff will cause the pump to cease operation, should a control failure cause the pump to run in a dry wet well. The thermostat shall reset automatically when the motor cools to a safe operating temperature.

.5 The common motor pump shall be of #416 stainless steel threaded to take pump impeller and impeller.

.5 Motor shall be protected by one rotary mechanical seal. Seal face shall be carbon and ceramic and lapped to a flatness of one light band.

.6 The pump impeller shall be of the recessed type to provide an open unobstructed passage through the volute for the solids. Impeller shall be engineered thermoplastic (MC/MGF) or ductile iron (MGH) and shall be threaded onto stainless steel shaft.

.7 All iron castings shall be pre-treated with phosphate and chromic rinse and to be painted before machining, and all machined surfaces exposed to the sewage water to be re-painted. All fasteners to be 302 stainless steel.

.8 The motor power cord shall be 14 GA SJOW/SJOWA or SOOW. The cable jacket shall be sealed at the motor entrance by means of a rubber compression washer and compression nut. A heat shrink tube filled with epoxy shall seal the outer cable jacket and the individual leads to prevent water from entering the motor housing.

.9 The pump shall be complete with integral float and power cord.

.10 High level alarm system with audible signal and test button suited for 120/1/60 with plug. Supply sufficient cord length to nearest plug.

.11 Acceptable manufactures:
Myers SRM-4A
Barnes
Grundfos

Part 3 Execution

3.1 SUMPS AND PUMPS

.1 Install in accordance with manufacturers recommendations.

.2 Clean sump upon completion.

.3 Confirm operation of pumps, controls, and high level alarms.

3.2 FIELD QUALITY CONTROL

.1 Check power supply.

.2 Check starter protective devices.

.3 Start up, check for proper and safe operation.

.4 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.

.5 Adjust flow from water-cooled bearings.

.6 Adjust impeller shaft stuffing boxes, packing glands.

.7 Demonstrate equipment operation as directed by consultant.

END OF SECTION

Part 1 General

1.1 REFERENCE

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

.2 National Air Duct Cleaners Association (NADCA): “Assessment, Cleaning & Restoration of HVAC Systems (ACR).

.3 National Air Duct Cleaners Association (NADCA): “Understanding Microbial Contamination in HVAC Systems”.

.4 National Air Duct Cleaners Association (NADCA): “Introduction to HVAC System Cleaning Services”.

.5 National Air Duct Cleaners Association (NADCA): Standard 05 “Requirements for the Installation of Service Openings in HVAC Systems”.

.6 Underwriters’ Laboratories (UL): UL Standard 181.

.7 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62, "Ventilation for Acceptable Indoor Air Quality".

.8 Environmental Protection Agency (EPA): "Building Air Quality".

.9 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): “HVAC Duct Construction Standards - Metal and Flexible”.

.10 North American Insulation Manufacturers Association (NAIMA): "Cleaning Fibrous Glass Insulated Air Duct Systems".

1.2 SPECIAL PROVISIONS

.1 Qualification of the HVAC System Cleaning Contractor

.1 Membership: The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.

.2 Certification: The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

.3 Supervisor Qualifications: A person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.

.4 Experience: The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning as requested by the owner. Bids shall only be considered from firms, which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

.5 Equipment, Materials and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labour to adequately perform the specified services.

.1 The contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., contractors should comply with applicable national safety codes and standards.

.2 The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification

.3 Contractor shall submit to the owner all Material Safety Data Sheets (MSDS) for all chemical products proposed to be used in the cleaning process.

.6 Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in this state. Contractor shall comply with all Federal, state and local rules, regulations, and licensing requirements.

1.3 STANDARDS

.1 NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).

.1 All terms in this specification shall have their meaning defined as stated in the NADCA Standards.

.2 NADCA Standards must be followed with no modifications or deviations being allowed.

1.4 DOCUMENTS

.1 Mechanical Drawings: The owner shall provide the HVAC system cleaning contractor with one copy of the following documents:

.1 Project drawings and specifications.

.2 Approved construction revisions pertaining to the HVAC system.

.3 Any existing indoor air quality (IAQ) assessments or environmental reports prepared for the facility.

Part 2 Products

2.1 SCOPE OF WORK

.1 This section defines the minimum requirements necessary to render HVAC components clean, and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards.

.2 The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

.3 The HVAC system includes any interior surface of the facility's existing air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts to the air handling units (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system. The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems. This applies to the duct systems from SF-1, SF-2, SF-3, SF-4, SF-5, SF-6, HVAC-1, HV-1 and HV-2.

Note: Users of this specification must modify the above paragraph to succinctly and specifically define those systems and components requiring cleaning.

2.2 HVAC SYSTEM COMPONENT INSPECTIONS AND SITE PREPARATIONS

.1 HVAC System Component Inspections: Prior to the commencement of any cleaning work, the HVAC system cleaning contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. The cleanliness inspection should include air handling units and representative areas of the HVAC system components and ductwork. In HVAC systems that include multiple air-handling units, a representative sample of the units should be inspected.

.2 The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented

.1 Damaged system components found during the inspection shall be documented and brought to the attention of the consultant.

.3 Site Evaluation and Preparations: Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.

.4 Inspector Qualifications: Qualified personnel should perform the HVAC cleanliness inspection to determine the need for cleaning. At minimum, such personnel should have an understanding of HVAC system design, and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

2.3 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

.1 Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.

.2 Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.

.3 Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.

.4 Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.

.5 Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.

.6 Service Openings: The contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.

.1 Contractor shall utilize the existing service openings already installed in the HVAC system where possible.

.2 Other openings shall be created by this contractor where needed and they must be created so they can be sealed by this contractor in accordance with industry codes and standards.

.3 Closures must not significantly hinder, restrict, or alter the airflow within the system.

.4 Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.

.5 Openings must not compromise the structural integrity of the system.

.6 Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.

.7 Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.

.8 Rigid fiberglass duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiberglass duct system closures.

.9 All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the consultant in project report documents.

.7 Ceiling sections (tile): The contractor may remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.

.8 Air distribution devices (registers, grilles & diffusers): The contractor shall clean all air distribution devices.

.9 Air handling units, terminal units (VAV, Dual duct boxes, etc.), blowers and exhaust fan: The contractor shall ensure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas to be cleaned include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. All visible surface contamination deposits shall be removed in accordance with NADCA Standards. Contractor shall:

.1 Clean all air handling units (AHU) internal surfaces, components and condensate collectors and drains.

.2 Assume that a suitable operative drainage system is in place prior to beginning wash down procedures.

.3 Clean all coils and related components, including evaporator fins.

.10 Duct Systems: This Contractor shall:

.1 Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas. Provide access doors specified in duct accessories to replace openings.

.2 Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests (see NADCA Standards).

2.4 HEALTH AND SAFETY

.1 Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.

.2 Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

.3 Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

2.5 MECHANICAL CLEANING METHODOLOGY

.1 Source Removal Cleaning Methods:

.1 The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods (See applicable NADCA Standards) and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

.1 All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.

.2 All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.

.3 All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.

.4 All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

.2 Methods of Cleaning Fibrous Glass Insulated Components:

.1 Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.

.2 Cleaning methods used shall not cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests (see NADCA Standards)

.3 Damaged Fibrous Glass Material:

.1 Evidence of damage: If there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, they shall be identified for replacement.

.2 Replacement: When requested or specified, Contractor must be capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement.

.3 Replacement material: In the event fiber glass materials must be replaced, all materials shall conform to applicable industry codes and standards, including those of UL and SMACNA.

.4 Replacement of damaged insulation is not covered by this specification.

.4 Cleaning of Coils:

.1 Any cleaning method may be used which will render the Coil Visibly Clean and capable of passing Coil Cleaning Verification (see applicable NADCA Standards). Coil drain pans shall be subject to Non-Porous Surfaces Cleaning Verification. The drain for the condensate drain pan shall be operational. Cleaning methods shall not cause any appreciable damage to, displacement of, inhibit heat transfer, or erosion of the coil surface or fins, and shall conform to coil manufacturer recommendations when available. Coils shall be thoroughly rinsed with clean water to remove any latent residues.

.5 Antimicrobial Agents and Coatings:

.1 Antimicrobial agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.

.2 Application of any antimicrobial agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.

.3 When used, antimicrobial treatments and coatings shall be applied in strict accordance with the manufacturer's written recommendations and EPA registration listing.

.4 Antimicrobial coatings shall be applied according to the manufacturer's written instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces.

2.6 CLEANLINESS VERIFICATION

.1 General:

.1 Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents and coatings.

.2 Visual Inspection:

.1 The HVAC system shall be inspected visually to ensure that no visible contaminants are present.

.1 If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the consultant reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards.

.2 If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

.3 NADCA vacuum test analysis shall be performed by a qualified third party experienced in testing of this nature through the HVAC commissioning contract.

.3 Verification of Coil Cleaning:

.1 Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA Standards).

2.7 PRE-EXISTING SYSTEM DAMAGE

.1 Contractor is not responsible for problems resulting from prior inappropriate or careless cleaning techniques of others.

2.8 POST-PROJECT REPORT

.1 At the conclusion of the project, the Contractor shall provide a report to the consultant indicating the following:

.1 Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.

.2 Areas of the system found to be damaged and/or in need of repair.

Part 3 Execution

.1 Not Applicable

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.

1.4 WARRANTY

.1 The VFD shall be warranted by the manufacturer for a period of five (5) years from date of substantial completion. 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.

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.

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.

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 to 40°C (14 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.

END OF SECTION

1.1 General

1.2 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.

1.3 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.

1.4 INSPECTORS QUALIFICATIONS

.1 Inspectors to be qualified to CSA W178.2.

1.5 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 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 CAN/ULC-S702, Mineral Fiber Thermal Insulation for Buildings.

.3 ASTM C612, Mineral Fiber Block and Board Thermal Insulation.

.4 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 C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.2 ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.

.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): National 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.

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 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.

.2 Insulation systems - insulation material, fasteners, jackets, and other accessories.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre as specified 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 C 335.

.3 Type C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma:

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52 Ma.

.3 Maximum "k" factor: to ASTM C553.

.4 Type C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma:

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52 Ma.

.3 Maximum "k" factor: to ASTM C553.

.5 Manufacturers:

.1 All materials must be supplied by the same manufacturer.

.2 Acceptable Materials:

.1 Johns Manville

.2 Fibreglass Canada

.3 Knauf

.4 Manson

.5 Roxul

2.3 JACKETS

.1 Canvas:

.1 220 g/m² (0.0451 lb/ft²) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

.2 Aluminum:

.1 To ASTM B 209 with moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.5 mm (26 gauge) sheet.

.3 Finish: Smooth.

.4 Jacket banding and mechanical seals: 15 mm (1/2") wide, 0.5 mm (26 gauge) thick stainless steel.

.5 Provide exterior silicone sealant on all joints.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.

.4 ULC Listed Canvas Jacket:

.1 220 g/m² (0.0451 lb/ft²) 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 Duro Dyne 1A-22 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.

.11 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2 (0.062 lb/ft^2).

.12 Banding: 15 mm (1/2") wide, 0.5 mm (26 gauge) thick stainless steel.

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 TIAC National 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 thickness' 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 exhaust ducts exposed (visible) in space being served	none	
Outdoor air intake ductwork and plenums	C-1	50 mm (2")
Exhaust plenums dampers and louvres	C-1	25 mm (1")
Interior acoustically lined ducts	none	
Last 1.5m of Exhaust duct	C-1	25 mm (1")
Fire wrapped duct as indicated	C-3	50 mm (2")
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.

.3 Finishes: Conform to following table:

Application	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed	Canvas	Canvas
Outdoor, exposed to Precipitation	Aluminum	Aluminum

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 C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.2 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.

.3 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.

.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): National 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.

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 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.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre as specified 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 C 335.

.3 Type A-1: Rigid moulded mineral fibre 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.

.4 Type A-2: Mineral fibre faced with factory applied vapour retarder jacket.

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52 Ma.

.3 Maximum "k" factor: to ASTM C553.

.5 Type A-3: Flexible unicellular tubular elastomer.

.1 Insulation to ASTM C553 with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52 Ma.

.3 Maximum “k” factor: to ASTM C553.

.4 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants.

.6 Materials:

.1 All materials must be supplied by the same manufacturer.

.2 Acceptable Materials:
Fibreglass Canada
Knauf
Manson
Pittsburg Corning

2.3 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 (26 gauge) thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 To ASTM C553.

.2 Hydraulic setting or Air drying on mineral wool, to ASTM C 449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2 (0.062 lb/ft^2).

2.8 JACKETS

.1 Aluminum:

.1 To ASTM B 209M.

.2 Thickness: 0.50 mm (26 gauge) sheet.

.3 Finish: Smooth.

.4 Joining: Longitudinal and circumferential slip joints with 50 mm (2") laps.

.5 Fittings: 0.50 mm (26 gauge) 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 (26 gauge) thick at 300 mm (12") spacing.

.2 Canvas:

.1 220 g/m² (0.0451 lb/ft²) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

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 National 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 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3").

3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.

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

.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 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")
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	CANVAS	PVC
Exposed in mech. rooms	CANVAS	PVC
Concealed indoors	N/A	PVC
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 upgraded.

.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.

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 materials:
Newman Hattersley
Crane
Jenkins
Milwaukee
Toya

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 materials:
Quick Block
Erico

2.8 GAS REGULATOR

.1 Reduce pressure from 34.5 kPa (5 psi) to 1.74 kPa (7" WC) capacity as indicated.

.2 Acceptable products:
Singer
Schlumberger

.3 Vent interior relief valve to outdoors with gooseneck and stainless steel insect screen. Vent piping shall be sized as per manufacturers' requirements and recommendations.

.4 Isolate with lubricated plug valve and union connection.

Part 3 Execution

3.1 PIPING

.1 Install in accordance with applicable Provincial/Territorial Codes.

.2 Install in accordance with CAN/CSA B149.

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.5 Slope piping down in direction of flow to low points.

.6 Install drip points:

.1 At low points in piping system.

.2 At each connection to equipment.

.7 Use eccentric reducers at pipe size change installed to provide positive drainage.

.8 Provide clearance for access and for maintenance.

.9 Ream pipes, clean scale and dirt, inside and out.

.10 Install piping to minimize pipe dismantling for equipment removal.

.11 Install regulator vents to code. Terminate in open air with Gooseneck fitting complete with stainless steel screen.

.12 Paint gas piping with two (2) coats yellow paint. Banding of gas will not be accepted.

3.2 PIPING ON ROOF

.1 Support piping as follows or as per seismic requirements (1.8 M (6' - 0") O.C.) whichever is more stringent:
≤ 40 mm (1½") 2.4 M (8' – 0") O.C.
≥ 50 mm (2") 3.0 M (10' - 0") O.C.

.2 Provide support at each elbow and fitting.

.3 Provide support at each regular and/or isolating valve.

.4 Provide support within 600 mm (24") of each piece of equipment.

3.3 VALVES

.1 Install valves with stems upright or horizontal unless otherwise approved by Consultant.

.2 Install valves at branch take-offs to isolate each piece of equipment, and as indicated.

.3 Provide lubricated plug type when gas line is exterior of building or 65 mm (2½") and larger.

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

3.4 FIELD QUALITY CONTROL

.1 Test system in accordance with CAN/CSA B149. Requirements of authorities having jurisdiction.

.2 Provide copy of TSSA tag to the consultant.

3.5 PURGING

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

3.6 GAS SERVICE

.1 Arrange with local gas distributor to install gas service and gas meter. Pay all fees and charges to provide the gas service and gas meter.

.2 Install all the gas meters where indicated.

3.7 GAS FIRED EQUIPMENT START-UP

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

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.2 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 AND PRODUCT DATA

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

.2 Indicate on product data expansion tanks, air vents, separators, valves, strainers.

1.3 CLOSEOUT SUBMITTALS

.1 Submit maintenance data in accordance with general requirements.

Part 2 Products

2.1 PIPE LINE STRAINER

.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.

.4 Blowdown connection: NPS 25 mm (1").

.5 Screen: stainless steel with 1.19 mm (50 mil) perforations.

.6 Working pressure: 860 kPa (125 psi).

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 of each pump.

.4 Install ahead of each automatic control valve and as indicated.

.5 Strainer size to match pipe size.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 HVAC Water Treatment Section.

1.2 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.

.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.

.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.

1.3 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

1.4 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 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").

2.2 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.

2.3 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.

2.4 VALVES MANUFACTURERS

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

.2 Acceptable Manufacturers:

.1 Newman Hattersley Canada Ltd.

.2 Jenkins/Crane

.3 Milwaukee

.4 Toyo

.5 Kitz

2.5 VALVES

.1 Connections:

.1 NPS 50 mm (2") and smaller: screwed ends.

.2 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. Jenkins 810J.

.2 Elsewhere: Class 125, non-rising stem, solid wedge disc. Jenkins 310J.

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

.1 Mechanical Rooms:

.1 Rising stem, solid wedge disc, bronze trim. Jenkins 454J.

.1 Operators: handwheel.

.2 Non-rising stem, solid wedge disc, bronze trim. Jenkins 452J.

.1 Operators: handwheel.

.3 Butterfly valves: Application: Isolating each cell or section of multiple component equipment and where indicated.

.1 NPS 65 mm (2 1/2") and over: Flanged ends. Jenkins FIG 2232 ELJ.

.4 Globe valves: Application: Throttling, flow control, emergency bypass:

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

.1 With PFTE disc, as specified. Jenkins 106BJ. Bronze.

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

.1 With solid bronze disc, bronze trim, cast iron body. Jenkins 2342.

.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. Jenkins 587J.

.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 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.

.9 Jenkins 201SJ.

2.6 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 materials:

.1 Bell & Gossett Circuit Setters

.2 Armstrong

.3 Taco

.4 Tour & Anderson

2.7 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 materials:

.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 (2 1/2") and over where installed more than 2400 mm (96") above floor in Boiler Rooms and Mechanical Equipment Rooms.

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 and as follows:

.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 Valve size shall be one trade size smaller than piping.

.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 Drain and vent all new and existing piping, radiation, etc for a complete operable system.

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 FLUSHING AND CLEANING

.1 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.

.2 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.

.3 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.

.4 Coordinate flushing and cleaning of mechanical systems with HVAC water treatment contractor and HVAC systems commissioning contractor.

.5 Flush and clean new piping system in presence of Consultant.

.6 Flush after pressure test for a minimum of 4 hrs.

.7 Fill system with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hrs.

.8 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.

.9 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.

.10 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.

.11 Drainage to include drain valves, dirt pockets, strainers, every low point in system.

.12 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.

.13 Re-install strainer screens/baskets only after obtaining Consultant's approval and approval from HVAC water treatment contractor.

.14 Repeat system drain and flush as often as necessary to have a clean system.

.15 Disposal of cleaning solutions to be approved by authority having jurisdiction.

.16 Isolate new piping system from existing system as required for system cleaning.

.17 After hydronic system is cleaned, refill with clean water and chemical as per chemical supplier treatment.

3.8 EXISTING SYSTEM DRAINAGE

.1 Drain existing hot hydronic system as required to facilitate system renovations.

.2 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

END OF SECTION

Part 1 General

1.1 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.

1.2 MAINTENANCE DATA

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

Part 2 Products

2.1 IN-LINE CIRCULATORS

.1 Volute: bronze radially split, with screwed or flanged design suction and discharge connections.

.2 Impeller: bronze.

.3 Shaft: alloy steel with copper sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135°C (275°F).

.5 Coupling: flexible self-aligning.

.6 Motor: resilient mounted, drip proof, sleeve bearing, as indicated.

.7 Capacity: as indicated.

.8 Design pressure: 1207 kPa (175 psi).

.9 Acceptable material:

.1 Bell & Gossett model

.2 Armstrong

Part 3 Execution

3.1 INSTALLATION

.1 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.

.2 Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommended tolerance. Check oil level and lubricate. After run-in, tighten glands.

.3 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.

.4 Pipe drain tapping to floor drain complete with isolating valve.

.5 Install volute venting pet cock in accessible location.

.6 Check rotation prior to start-up.

.7 Install pressure gauge with plug cocks on inlet and outlet on pump.

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.

2.2 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, moistureproof 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, moistureproof 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 Approved 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 Approved 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 Approved 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:

Anaconda “Vibration Eliminators” by Anamet

Vibration Absorber Model VAF by Packless Industries

Vibration Absorbers by Superior Valve Co

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 materials:

.1 Unistrut

.2 Or equal

Part 3 Execution

3.1 GENERAL

.1 Hard copper to be used. Throughout the project, the use of annealed copper shall not be used without approval of the consultant.

.2 Install in accordance with CSA B52, EPS 1/RA/2 and ANSI/ASME B31.5.

.3 Connect to equipment with isolating valves and unions.

.4 Provide space for servicing, dissembly and removal of equipment and components all as recommended by manufacturer.

.5 Protect all openings in piping against entry of foreign material.

.6 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.

.7 Provide number of refrigerant circuits and appropriate corresponding piping as per manufacturer's recommendations and requirements.

3.2 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.

3.3 PIPING INSTALLATION

.1 General:

- .1 Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
- .3 Provide trap at base of risers greater than 2.4m (8') high and at each 7.6m (25'-0") thereafter.
- .4 Provide inverted deep trap at top of each riser.
- .5 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.

3.4 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.

3.5 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.

3.6 INSTRUCTIONS

.1 Post instructions in frame with glass cover in accordance with Operation and Maintenance Manual Section and CSA B52.

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:

Ashland Inc. (no alternates).

2.2 POT FEEDER

.1 Existing.

2.3 WATER TREATMENT FOR HYDRONIC SYSTEMS

.1 Hot water heating system: Existing pot feeder.

.2 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.

.3 Balancing valve set for 2% pump capacity.

2.4 CHEMICALS

.1 Provide 1 year's supply.

2.5 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.

2.6 CLEANING CHEMICALS

.1 Provide as required to make system clean.

.2 Cleaner chemical: compatible and of the same manufacturer of the water treatment supplier.

2.7 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 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.

3.3 START-UP

.1 Start up water treatment systems in accordance with manufacturer's instructions.

3.4 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 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.

.6 Certificates:

.1 Upon completion, furnish certificates confirming satisfactory installation and performance.

.7 Commissioning Reports:

.1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, all other data required by Consultant.

.8 Commissioning activities during Warranty Period:

.1 Check out water treatment systems on regular basis and submit written report to Consultant.

3.5 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.

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

Size Type	Class A Gauge	Class B Gauge	Class C Gauge
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

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

2.2 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 materials:

.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 materials:

.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
2500 (10")	A
1500 (6")	A
1000 (4")	A
750 (3")	A
500 (2")	B
250 (1")	B
125 (0.5")	C

.2 Seal classification:

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

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

.3 Class C: transverse joints and connections made air tight with 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).

.1 Acceptable materials:

.1 Duro Dyne S-2

.2 Foster

2.6 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm (2") wide.

.1 Acceptable material:

.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 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.

2.10 HANGERS AND SUPPORTS

.1 Band hangers: use on round and oval ducts only up to 500 mm (20") diameter, of same material as duct but next sheet metal thickness heavier than duct.

.2 Trapeze hangers: ducts over 500 mm (20") diameter or longest side, to ASHRAE and SMACNA.

.3 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)

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.1 Acceptable material:

.1 Myatt fig. 485

.2 For steel joist: manufactured joist clamp or steel plate washer.

.1 Acceptable material:

.1 Grinnell fig. 61 or 60

.3 For steel beams: manufactured beam clamps:

.1 Acceptable material:

.1 Grinnell Fig. 60

Part 3 Execution

3.1 GENERAL

.1 The following systems shall conform to these requirements:

System	Class	Material
HVAC Supply and Return General Exhaust Ventilation Plenum Exhaust Plenum	B B B B	Galvanized steel Galvanized steel Galvanized steel Galvanized steel
Individual Exhaust	C	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 SEALING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

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

3.4 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.

3.5 LEAKAGE TESTS

.1 Co-ordinate leakage testing with TAB contractor. 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.

.5 Ensure all systems are clean prior to start up.

3.7 ROOF MOUNTED DUCT SUPPORT

.1 Provide zero penetration duct support on roof where indicated.

.2 Base shall be made of high density polypropylene with UV protection.

.3 Frames shall be galvanized. All fastenings, rods, nuts, washers, etc. shall be stainless steel.

.4 Provide shop drawings as specified. Install to manufacturers recommendations.

.5 Acceptable materials:

.1 Portable pipe hanger

.2 Bigfoot systems

.3 Trikon Systems

3.8 INSTALLATION REQUIREMENTS

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

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

.3 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

.4 ANSI/NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations.

.5 CSA B228.1, Pipes, Ducts and Fittings for Residential Type Air Conditioning.

1.2 PRODUCT DATA

.1 Submit product data in accordance with general requirements.

.2 Indicate the following:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

1.3 CERTIFICATION OF RATINGS

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

Part 2 Products

2.1 GENERAL

.1 Manufacture in accordance with CSA B228.1.

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.

.2 Material:

.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at -40°C (-40°F) to plus 90°C (194°F), density of 1.3 kg/m.

2.3 ACCESS DOORS IN DUCTS

.1 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 materials:
Nailor
E. H. Price
Titus

2.4 TURNING VANES

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

.2 Acceptable materials:
Duro Dyne
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 material:
Duro Dyne IP1 or IP2
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 materials:
Greenheck GPR – 600 mm (24") high
Penn

2.7 SPIN-IN COLLAR

.1 Construction: conical spin-in collar complete with spin-in bead and crimped collar connection.

.2 Provide balancing damper where indicated.

.3 Acceptable materials:

.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.

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 materials:

.1 Duro Dyne

.2 National Controlled Air (NCA)

.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:
Duro Dyne
Ductmate

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 Material
EH Price AE-1

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.

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 following:

.1 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 materials:

.1 Ruskin

.2 Nailor

.3 National Controlled Air (NCA)

.4 T.A. Morrison

.5 Tamco

.6 Ventex/Alumavent

.7 United Enertech

.8 Safeair-Dowco (stainless steel)

.9 Greenheck

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 materials:

.1 Ruskin
.2 Nailor
.3 National Controlled Air (NCA)
.4 T.A. Morrison
.5 Tamco
.6 Greenheck
.7 Ventex/Alumavent

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.

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 kPa (36 psi) differential across damper.

.2 Pressure drop: at full open position to be less than 100 kPa (15 psi) 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.

.8 Acceptable materials:
Honeywell
Johnson
T. A. Morrison
National Controlled Air (NCA)
Tamco
Ruskin
Nailor
Henderson Industrial
Ventex/Alumavent

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, with 10 year warranty.

.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 material:
Duro Dyne
Henderson Industrial

2.3 BACK DRAFT DAMPERS

.1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted or counterweighted, as indicated.

.2 Acceptable materials:

T.A. Morrison
Tamco Series 7000
Ruskin
Nailor
National Controlled Air (NCA)
Henderson Industrial
Ventex/Alumavent

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.

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 materials:

.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 C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.4 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.

.5 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 DUCT LINER

.1 General:

- .1 Rigid fibrous glass duct liner: air stream side faced with mat facing.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
- .3 Acceptable material:
  - .1 Johns Manville, Permacote Linacoustic R-300
  - .2 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: 36 kg/m² (7.4 lb/ft²).
- .4 Thermal resistance to be minimum 750 mm (30") C/W for 25 mm (1") thickness 1150 mm (45") C/W for 40 mm (1½") thickness when tested in accordance with ASTM C177, at 24°C (75°F) mean temperature.

2.2 ADHESIVE

.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 -29°C (-20°F) to 93°C (200°F).

.3 Acceptable material:

- .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 material:

.1 Duro Dyne

.2 Ductmate

2.4 JOINT TAPE

.1 Poly-Vinyl treated open weave fiberglass membrane 50 mm (2") wide.

.2 Acceptable materials:

.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 materials:

.1 Duro Dyne 1A-94

.2 Ductmate

Part 3 Execution

3.1 GENERAL

.1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.

.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 Acceptable materials:

.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

.7 Provide factory mounted speed control for all direct drive motors.

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.

.3 Size, type, and capacity: as indicated

.4 To NFPA 96 requirements where indicated.

2.3 EXISTING EXHAUST AIR FANS

.1 Refurbish existing exhaust air fans as follows:

.1 Vacuum entire unit interior.

.2 Lubricate all bearings.

.3 Replace fan belt(s).

.4 Rebalance to capacity indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Provide flexible duct connection at roofline.

.3 Provide backdraft damper at building exterior penetration.

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 him 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 materials:

.1 E.H. Price
.2 Nailor
.3 Krueger
.4 Titus
.5 Carnes
.6 Seiho
.7 Metalaire

2.2 SUPPLY GRILLES (S-1)

.1 General: with opposed blade dampers as indicated, concealed manual operator and gaskets.

.2 Steel 25 mm (1") border, double deflection with airfoil shape, horizontal face and vertical rear bars, screwed fastening, finish selected by Consultant. **(Provide AE-1 volume extractor)** Model: E.H. Price 32NLA.

.3 Type, size, and capacity: as indicated.

2.3 RETURN AND EXHAUST GRILLES

.1 General: with opposed blade dampers as indicated, concealed manual operator and gaskets **USER SELECTION: and fire stop flap where indicated**.

.2 Type R1: aluminum 25 mm (1") border, single 45 deflection, horizontal face bars, at 15 mm (½") spacing quick release fastener c/w 25 mm (1") replicable media permanent frame filter, finish selected by Consultant. Model: E.H. Price 735FFNLA Type

.3 Type, size, and capacity: as indicated.

2.4 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 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: Kynar 500
Colour: to Consultant's approval.

.9 Acceptable materials:
Greenheck
Construction Specialties
E.H. Price
Krueger
Ruskin
Ventmaster
Ventex
Nailor

2.2 GRAVITY ROOF OUTSIDE AIR INTAKES AND RELIEF VENTS

.1 Factory manufactured louvred penthouse.

.1 3 mm (1/8") thick stormproof extruded aluminum louvers with mitred corners. Brace and support louvres at 1500 mm (5') intervals.

.2 2 mm (0.081") thick insulated aluminum sheet roof.

.3 Constructed of 50 mm x 50 mm x 6 mm (2" x 2" x ¼") aluminum angles for roof support and corner angle.

.4 15 mm x 15 mm x 0.063 diameter (½" x ½" x 1.6" diameter) intercrimp aluminum screen on back of all sides.

.2 Provide roof curb sized to suit penthouse or flat or sloped roof as required or indicated. Curb to place bottom louvre minimum 250 mm (10") above roof.

.3 Maximum throat velocity 3.3 m/s (11 ft/s) intake.

.4 Maximum loss through unit: 15 Pa (0.06" in w.c.) static pressure.

.5 Finish as specified by consultant.

.6 Shape and size as indicated.

.7 Acceptable manufacturers:
Greenheck WRH
Nailor 1720
Carnes GLAB
Penn Barry
Ventex

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: Kynar 500

Colour: to Consultant's approval.

.8 Options:

.1 Straight duct extension.

.2 Perimeter flange frame.

.9 Acceptable materials:

Greenheck Model BVF
Construction Specialties
E.H. Price
Krueger
Ruskin
Ventmaster
Ventex
Nailor

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

SF-5 DX cooling coil & associated remote rooftop condensing unit are to be part of itemized price. Refer to Itemized Price No. 3 in division 1 specification.

1.1 REFERENCES

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

.2 CAN/CGSB 1.181, Ready Mixed Organic Zinc, Rich Coating.

.3 ANSI/NFPA-90A, Installation of Air Conditioning and Ventilating Systems.

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. It is the responsibility of the Contractor to ensure units can fit through openings provided prior to shipping. All equipment shall be factory tested prior to shipment.

.2 It is the responsibility of the Contractor and/or Air Handling Unit Manufacturer to determine which units shall be delivered in sections and assembled on site in place. It is the responsibility of the Contractor to install the units in place to the standards of the Manufacturer.

.3 Where units are required to be constructed in place assemble units to manufacturer's requirements. TAB Contractor shall pressure test air units which are constructed in place. Refer to Section 20 06 11.

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.

Part 2 Products

2.1 GENERAL

.1 Field Factory assembled components to form units supplying air at design conditions as indicated and specified.

Acceptable materials:
Engineered Air
Haakon
Bousquet
Daikin

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__	___
Return Plenum	__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 Indoor suspended units shall be provided with 15 mm (1/2") holes in the base channels to accommodate hanger rods (supplied by others).

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 Wire fan motors to external unit mounted junction box (one per fan motor) complete with terminal strip.

.4 Run all wiring in conduit to standards of Division 16.

2.4 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.

2.5 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.

.8 Refrigerant Superfin evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor. Solenoid valves, expansion valves, and related accessories are to be provided and installed by the refrigeration contractor. Refer to Itemized Price No. 3.

.9 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. Provision for use of thermal expansion valves must be included for variable air volume and/or make-up air applications. Refer to Itemized Price No. 3.

.10 Provide lamiflo integral face and bypass coil-damper units arranged with vertical tubes. The units shall consist of alternate vertical, coil and bypass sections in galvanized steel casings of not less than 1.3 mm (18 gauge). Coil and bypass sections shall be balanced to provide equal air pressure drop at each extreme of operation. Maximum header length of a single section shall be 1625 mm (64").

Multiple row coils shall be of staggered tube design circuited to optimize capacity with minimum pressure drop. Coils requiring Provincial or State Boiler and Pressure Vessel Code certification, shall be labelled a Category "H" fitting for headers less than 150 mm (6") in diameter, less than 0.4 m3 (1.5 ft3) in volume, and a maximum of 2069 kPa (300 psig) working pressure. All such costs shall be fabricated with mild steel tubes and schedule 40 headers.
Opposed blade dampers shall be provided on both face and bypass channels on the entering air side. In addition, provide a single blade damper on the leaving air side of the coil channel, to eliminate coil "wiping". Blades shall be heavy gauge galvanized steel, welded to steel damper rods operating in oil impregnated bronze bushings. Bushings shall be installed at no more than 1200 mm (48") centres. Opposed blade dampers shall interlock on closing and require no sealing gaskets. Damper linkage shall be non-adjustable, to prevent slippage and subsequent air leakage.

2.6 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.

.3 50 mm (2") Replaceable MERV13 Filters

.4 Filter media shall meet U.L. Class 2 standards.

.5 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.

2.7 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 be tested and certified under AMCA Standard 500-89 by an accredited test laboratory. These dampers include: rigidly formed galvanized steel frame with corner reinforcing brackets; heavy duty galvanized damper blades secured with bolts to continuous 15 mm (1/2") aluminum drive rods; all weather PVC double seal blade gasket; tempered aluminum alloy blade end seal, epoxy enamel coated; oil impregnated bronze bushings; and non-corrosive smooth acting linkage.

.4 Certified low leak, dampers shall also be provided for return air dampers, exhaust (relief) air dampers.

.5 Mixing dampers shall be parallel blade type.

.6 Two position inlet dampers shall be parallel blade type.

.7 Motorized relief dampers shall be opposed blade type.

.8 Gravity relief dampers shall be single blade gasketed design.

.9 Provide Engineered Air satin coat steel mixers downstream of mixing box to provide thorough air mixing to prevent stratification.

.10 Face and bypass dampers shall be opposed blade type.

.11 Damper operators will be supplied by the temperature controls contractor and factory installed by the unit manufacturer.

2.8 COMPONENTS

.1 Incorporate the following components to provide a complete system.

- .1 Outdoor air section
- .2 Mixing section
- .3 Filter section
- .4 Heating coil section (SF-5, SF-6)
- .5 Face & Bypass heating coil (SF-1 thru SF-4 Only)
- .6 Cooling coil section (SF-5 only)
- .7 Supply air blower

2.9 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 Steel filter frames with disposable filter media.

2.10 CAPACITY

.1 Provide unit capacity indicated.

.2 The drawings indicate maximum physical sizes allowed for the air handling units: The noted ˈmaxˈ dimension are the approximate largest dimension permitted to allow for suitable clearance/service space around the unit. If an ˈalternateˈ unit is selected it is the responsibility of the Contractor to confirm that the unit fits in the allocated space and works with the design as shown, the proposed layout abides by the specific service/required clearances of that alternate unit and that the alternate unit does not exceed the noted/max dimension.

2.11 REMOTE CONDENSING UNITS (REFER TO ITEMIZED PRICE NO. 3)

.1 General:
Factory-assembled, single piece, air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, holding charge (R-407A), and special features required prior to field start-up. Unit shall be rated in accordance with ARI Standard and be CSA approved.

Condensing units shall be designed for a minimum of 8°C (15°F) liquid subcooling. Multiple compressor/condenser circuits shall be separate from each other. Suction and liquid lines shall be extended to the outside of the cabinet. Service ports fitted with Schraeder fittings shall be connected to the suction and discharge lines for charging or pressure gauge readings. Controls for compressor units shall include compressor and condenser fan motor contactors, control circuit transformer, cooling relays, non-recycling pumpdown relays, ambient compressor lockout, manual reset high pressure controls and automatic reset low pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.
Provide five minute anti-cycle timers.
Provide interstage time delay timers.
Provide hot gas bypass connection on the lead compressor.
Provide low ambient controls.
Provide separate compressor compartment complete with 25 mm (1") 24 kg/m3 (1.5 lb/ft3) insulation and hinged access doors.
Refrigeration specialties such as solenoid valves, TX valves, etc., to be supplied and installed by refrigeration contractor.

.2 Unit Cabinet:

.1 Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a prepainted baked enamel finish.

.2 A heavy gage roll-formed perimeter base rail with forklift slots and lifting holes shall be provided to facilitate rigging.

.3 Fans:

.1 Condenser fans shall be direct driven, propeller-type, discharging air vertically upward.

.2 Fan blades shall be balanced.

.3 Condenser fan discharge openings shall be equipped with PVC coated steel wire safety guards.

.4 Condenser fan and motor shaft shall be corrosion resistant.

.5 Condenser fans shall be direct driven propeller type arranged for vertical draw through air flow. Motors shall be weather resistant type, with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted on a formed orifice plate for optimum efficiency with minimum noise level.

.4 Compressor:

.1 Compressor shall be of the scroll type.

.2 Compressor shall be mounted on vibration isolators.

.3 Compressors shall include overload protection.

.5 Condenser Coil:

.1 Condenser coil shall be air-cooled and circuited for integral subcooler.

.2 Coil shall be constructed of aluminum fins mechanically bonded to internally grooved seamless copper tubes which are then cleaned, dehydrated, and sealed.

.6 Controls and Safeties:

.1 Minimum control functions shall include:

.1 Control wire terminal blocks.

.2 Five-minute recycle protection to prevent compressor short-cycling.

.3 Compressor lockout on auto-reset safety until reset from thermostat.

.2 Minimum Safety devices which are equipped with automatic reset (after resetting first at thermostat), shall include:

.1 High discharge pressure cutout.

.2 Loss-of-charge cutout.

.7 Acceptable manufacturer:
Engineered Air, Daikin

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 WARRANTY

.1 One (1) year on parts and labour on all components.

.2 Ten (10) years on heat exchanger.

3.7 EQUIPMENT DELIVERY

.1 Air handling units shall be ordered immediately after award of tender. Units shall be delivered to the site prior to the start of construction and stored in location determined on site.

.2 Air handling units shall be delivered to the site shrink wrapped.

.3 All costs to store the air handling units on site and relocate them to their respective spaces shall be the responsibility of this Contractor.

END OF SECTION

Part 1 General

HVAC-1 is part of an itemized price. Refer to Itemized Price No. 1 in the division 1 specification.

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.

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.

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.

1.4 WARRANTY

.1 Manufacturer hereby warrants refrigeration compressors in accordance with GC 24, but for 5 years.

.2 Manufacturer hereby warrants the gas heat sections for a minimum of 10 years.

Part 2 Products

2.1 HIGH EFFICIENCY HVAC EQUIPMENT (15 TONS & LESS)

.1 Efficiency:

.1 Exceeds the minimum ASHRAE 90.1 Energy standards ratings by 2 units (5 ton and under) and by 1.0 unit (over 6 tons).

.2 Units under 5 tons of cooling meet a SEER rating of 15.0.

.3 Units 6 tons of cooling and larger meeting a EER rating of 12.0 (9.6 for 12½ ton unit).

.4 Electronic controls with data link and diagnostic operation.

.5 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 High efficiency motor suitable for voltage indicated. Provide two-speed motors on units 7½ tons and larger where noted in Schedule.

.6 All units shall be of the same manufacturer.

.7 Provide minimum 3-stage cooling (2 DX, 1 free cooling) control.

.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: removable gasketted panels with screwdriver operated flush cam type fasteners. Provided hinged access doors with $^{1}/_{4}$"polyamide handles turn.

.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.

.6 Provide hinged side filter access door.

.4 Fans:

.1 Centrifugal, forward curved impellers, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, isolated hinge mounted motor. Vibration isolators: 95% efficiency.

.5 Air Filters:

.1 50 mm (2") thick MERV 13 filters.

.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.

.3 Provide minimum 2:1 turndown burner

.7 Refrigeration:

.1 Conform to CSA B52 and ANSI/UL 1995 requirements.

.2 Compressor/condenser section:

.1 Semi-Hermetic variable speed compressor(s), vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and with control to liquid line solenoid valve.

.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: Variable speed compressors, hot gas bypass and or cylinder unloading.

.7 Refrigerant: R410A.

.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 Controls and Safeties:

.1 Electronic control.

.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 Unit shall have 0°F low ambient operation.

.16 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.

.17 Supply-air sensor located in the unit and detect both heating and cooling operation.

.18 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.

.9 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.

2.2 SYSTEM CONTROL

.1 Equipment control will be by the unit manufacturer and integral economizer controls.

.2 System controls will be by Building Automation System Contractor.

.3 The HVAC equipment shall be capable of controlling the outdoor air damper through a 0-10 VDC BAS signal via the CO_2 port input. Manufacturers shall visit the site and reset equipment so 0 volts is close, 10 volts is 100% open and in a linear response from the BAS controls.

.4 CO_2 control of economizer damper with W7220 economizer control.

2.3 CAPACITY

.1 As indicated.

2.4 ACCESSORIES

.1 600 mm (24") high roof curb.

.2 Vibration rail.

.3 Opposed blade economizer dampers.

.4 Condenser coil guard.

.5 Power exhaust.

.6 Stainless steel vertical extension on flue gas discharge.

.7 Stainless steel heat exchanger.

2.5 ELECTRICAL REQUIREMENTS

.1 As indicated.

2.6 ACCEPTABLE MATERIALS

.1 Carrier

.2 Trane

.3 Lennox

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 manufacture shall perform start-up and commissioning.

3.3 SPARE PARTS

.1 Two (2) complete sets of filters.

.2 One (1) set of spare belts.

3.4 WARRANTY

.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.

END OF SECTION

Part 1 General

HV-1 is to be part of itemized price. Refer to Itemized Price No. 2 in division 1 specification.

1.1 REFERENCES

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

.2 CAN/CGSB 1.181, Ready Mixed Organic Zinc, Rich Coating.

.3 ANSI/NFPA-90A, Installation of Air Conditioning and Ventilating Systems.

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.

.2 The heat exchanger shall be manufactured by the air-handling manufacturer as an integrated package.

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.

Part 2 Products

2.1 GENERAL

.1 Field Factory assembled components to form units supplying air at design conditions as indicated and specified.

Acceptable materials:
Engineered Air – DJE Series
Haakon
Bousquet

2.2 UNIT CONSTRUCTION

.1 Unit casing shall be of minimum 1.3 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 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.

.3 Units shall be provided with gasketed access doors to the following components: fans and motors; filters; dampers and operators; and access plenums. Access doors shall be large enough for easy access.

.4 Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

.5 All units shall be internally insulated with 25 mm (1") thick 24 kg/m³ (1.5 lb./ft³) density, neoprene coated fibre glass thermal insulation.

24 kg/m³ (1.5 lb/ft³) 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.

.6 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, and: louvres or hoods on air intakes and exhaust openings with 25 mm (1") galvanized inlet screens; rain gutters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 50 mm (2") with three break interlocking design; outer wall panels extend a minimum of 6 mm (1/4") below the floor panel; drain trap(s) for field installation.

.7 Units shall be provided with gasketed access doors to the following components: fans and motors; filters; dampers and operators; access plenums and access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.8 Provide hinged access doors, fully lined, with zinc plated piano hinges and brass pins, with a minimum of two camlock fasteners for all units over 1200 mm (48") high.

Provide hinged access doors, fully lined, with zinc plated piano hinges and brass pins, Ventlock 310 handles, operable from both sides for all units over 1200 mm (48") high. 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.

.9 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 600 mm (24") high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 25 mm (1") upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof mounting curb shall be provided by the Roofing Subcontractor.

2.3 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 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.

.3 All single phase belt drive motor applications shall include rubber isolation for motors .19kw (1/4 hp) through 1.1kW (1½ hp). Provide internal spring isolation for single phase motors over 1.1kW (1½ hp).

.4 Fan motors shall be ODP high efficiency.

2.4 GAS HEAT SECTION (DJ) INDIRECT FIRED

.1 General

.1 Heating units shall have an indirect natural gas fired heating section that is ETL, C-ETL, approved for both sea level and high altitude areas. The entire assembly shall be approved and labelled by a nationally recognized certification agency.

.2 Operating natural gas pressure at unit(s) manifold shall be 1750 Pa (7" w.c.)

.3 Gas fired units shall be approved for operation in -40ºC/-40ºF locations.

.2 Heat Exchanger

.1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal tubulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 25 mm (1") of insulation between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchangers are not acceptable.

.2 Units shall be complete with high efficiency heat exchangers shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

.3 The burner assembly shall be a blow through positive pressure type with a combustion air damper interlocked with main gas valve to provide optimum air/fuel ratios at all inputs with 80% or higher efficiency throughout its operating range. Flame surveillance shall be with a solid state programmed flame relay utilizing a flame rod for gas operation. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be a heat reflective galvanized steel liner. Burners to be manufacturer by Maxon, Ovenpak or Engineered Air. Atmospheric burners or burners requiring power assisted venting are not acceptable.

.4 Modulating burners shall have a 15:1 turndown providing that the minimum input is at least 100 MJ.

.5 Controls: An integral control panel shall be completely pre-wired with motor contactors, overloads, control transformer, high limit, combustion air flow switch, terminal block and all necessary relays. The control of the unit shall be provided with electronic control using modulating discharge air sensor by Controls Division.

.6 Provide warm weather bypass control for all units utilizing modulating discharge air controls, to allow the supply fan to continue operating during the purge cycle whenever ambient temperature is above the burner ambient set point.

.7 All operating controls and functions shall be factory tested prior to shipment.

.8 Operating natural gas pressure shall be 7" (1750 Pa) W.C.

.9 Electrical:

.1 All units to be completely pre-wired including motor starter and overloads. The connection of electrical power supply and all field wiring shall make the unit completely functional.

.2 Provide control transformer sized and wired to handle the electrical power requirements of the control system.

.3 Provide a unit mounted fused weatherproof disconnect switch sized and wired to handle switching of electrical power to the entire unit.

.10 Pre-wired equipment and factory installed controls.

.1 Air handling units to be factory wired and tested, and to be certified by a recognized approval agency: C.S.A.; C.E.T.L.

.2 Wiring to be in accordance with latest edition of the Canadian Electrical Code, Part 1, and pertinent sections of the Part 2 of the Code pertaining to specific equipment type and purpose. All wiring to be on interior of unit.

.3 All electrical circuits conduit to undergo a di-electrical strength test (C.S.A. C22.2-0), and to be factory tested and checked as to proper function.

.4 Pre-wired air handling units to bear an approved bilingual label with all the necessary identification marks, electrical data, and any necessary cautions as required b the C.E.C. Part 2.

2.5 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 1825 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.

.3 50 mm (2") 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 MERV 13.

.4 Filter media shall meet U.L. Class 2 standards.

.5 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.

.6 Where the filter gauges are provided on outdoor units they shall be mounted inside of a weatherproof enclosure with viewing window.

2.6 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") aluminium, 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 1067 mm (42"). Damper linkage brackets shall be constructed of galvanized metal.

.3 Damper actuators to be supplied by Controls Division controls manufacturer. Damper actuators to be factory installed and wired to unit control panel.

2.7 CONTROLS

.1 Controls and gas manifolds shall be contained in a control panel that provides easy access to contained components.

.2 Provide a system of motor control, including all necessary: terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors, and terminals for the connection of external control devices or relays.

.3 Provide electronic ignition of pilot through a spark rod and electronically programmed flame supervision controller.

.4 Automatic controls and gas manifolds to be housed in a control panel mounted on the air handling unit, on the access side, which meet the C.S.A/C.E.T.L. standard.

.5 Electronic Heating Control:

.1 Electronic control complete with solid state analyzer and discharge thermistor to maintain set point discharge air temperature and provide rapid response to small changes in discharge air temperature, incorporating modulating gas valve and proportional combustion air. Electronic heating controller to be Engineered Air DJM-3 or Nexus model NX3100 complete with display model NX550.

.2 Burner and unit control shall include the following standard features:

- Service analyzer.
- Linear gas and combustion airflow obtained via a built-in solid state linear algorithm.
- 40ºF minimum operating ambient temperature.
- Four (4) air change pre-purge on units with over 400 MBH input.
- Post purge.
- Interrupted pilot.
- Self-check on startup to make sure sir proving and discharge air sensors are operating within design tolerances.
- Controlled burner startup to make sure air proving and discharge air sensors are operating within design tolerances.
- Low fire stat.
- Controlled burner startup and shut down.
- Diagnostic lights for ease of set-up and service.
- Blower contactor that starts fan after burner pre-purge.
- Damper contact that allows fan to start after damper opens. Damper to close after fan stops and damper to close on flame failure.
- Non-recycling auto bypass low limit that has built-in sensor checking.
- Built-in sensor checking.
- Built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation.

2.8 COMPONENTS

.1 Incorporate the following components to provide a complete system.

<u>HV-1 unit:</u>

.1 Vertical return, horizontal intake plenum

.2 Relief section

.3 Filter section
.4 Supply blower section
.5 Indirect gas fired heat exchanger
.6 Vertical discharge plenum.

.2 Incorporate the following components to provide a complete system

HV-2 unit:

.1 Horizontal return, horizontal outdoor intake
.2 Relief section
.3 Filter section
.4 Supply air blower
.5 Indirect gas fired heat exchanger
.6 Vertical discharge plenum.

2.9 ACCESSORIES

.1 Internal wiring to terminal strip in Nema 1 enclosure with space for DDC controller.

.2 600 mm high roof curb.

2.10 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 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.

.2 Provide one (1) additional shieves and belts required for final air balance.

3.3 START-UP

.1 Unit manufacturer shall perform start-up.

3.4 SPARE PARTS

.1 One (1) complete set of filters.

.2 One (1) set of spare belts.

3.5 WARRANTY

.1 One (1) year on parts and labour on all components.

.2 Ten (10) years on heat exchanger.

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.

1.2 MAINTENANCE DATA

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

Part 2 Products

2.1 CAPACITY

.1 As indicated.

2.2 REHEAT COILS

.1 Extended surface type, constructed of 15 mm (1/2") O.D. seamless copper tube and continuous aluminum plate fins.

.2 Tubes shall be pressure bonded to the fin collars by expanding the tubes into the fin collars.

.3 Stagger tube design circuited to optimize capacity with minimum pressure drop.

.4 Die formed into a rippled pattern aluminum fins to provide maximum capacity with minimum air pressure drop and spaced not closer than 12 fins per 25 mm (per inch).

.5 Headers shall be seamless copper tubes with 3 mm (1/8") drain and vent connections brazed into tubes.

.6 Casings shall be constructed of heavy gauge galvanized steel with tube sheets having extruded tube holes.

.7 Coil shall be factory leak tested at 2070 kPa (300 psig) dry air pressure and shall be designed for 125 working pressure. Maximum water pressure drop shall be 15 kPa (2.17 psi or 5.0 ft w.c.) and maximum air pressure drop shall be 0.1 kPa (0.375 in w.c.).

.8 Acceptable materials:

.1 Engineered Air

.2 McQuay

.3 Madoc

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 lockshield globe 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.

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 CABINET CONVECTORS (H-1)

.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 primer coat.

.3 Catalogue rating: certified IBR ratings.

.4 Capacity: as indicated.

.5 Acceptable materials:

.1 Engineered Air C-1W

.2 Slant Fin

.3 Sigma

2.4 HORIZONTAL UNIT HEATERS (H-2)

.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 materials:

.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 Thermostats on outside walls: mount on insulated backplates.

.13 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.

.14 On fan forced units set discharge patterns and fan speeds to suit requirements prior to acceptance.

.15 Provide new filter media.

END OF SECTION

Part 1 General

1.1 GENERAL NOTE

.1 GENERAL

.1 This project is an upgrade of an existing DDC control system. The work shall include an upgrade to the existing and provision of a new BAS system including 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.

.2 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 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.

.3 APPROVED SYSTEMS

.1 Bids for the BAS contract will only be accepted from authorized vendors/installers of the Reliable Controls product:

.1 Set Point Building Automation Inc.
721 Rye Street
Peterborough, Ontario
K9J 6X1
Tel: (705) 745-1600
Contact: Mr. Mallory Remus

.4 SUBMITTALS

.1 Submit the six (6) copies of following information to the consultant and/or the KPRDSB 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.

.5 RELATED WORK

.1 Unless otherwise specified, the following work shall be furnished by others:

.2 The mechanical sub-contractor shall provide:

.1 Water treatment system mechanical wiring.

.3 The BAS contractor shall provide:

.1 AHU freeze stats and high limit

.4 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.

.6 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, 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 and install all operating software and dynamic system graphics on the Operator's Workstation. Workstation to be supplied by KPRDSB.

.2 Supply licenses for all supplied software directly to the KPRDSB Project Supervisor.

.8 System Remote Access

.1 WAN Access

.1 Provide necessary interface and cabling to connect the BAS to the KPRDSB WAN. Obtain the particular WAN system details from the Engineer or KPRDSB Project Supervisor.
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.

.7 SYSTEM SOFTWARE

.1 Operators Workstation Software and Graphical Interface

.1 The Operators Workstation software shall be the latest version of the manufacturers 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's 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 whenever specified system alarms are active.

.8 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°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 -50C to 50C 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°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.

.9 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 KPRDSB-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.

.10 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.

.11 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.

.12 TRAINING

.1 KPRDSB 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.

.13 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.

.14 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 KPRDSB 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.

.15 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:

.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 KPRDSB 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 & 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 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 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

.16 RELIABLE BAS DATABASE NAMING CONVENTIONS AND PROGRAMS

.1 Miscellaneous Equipment Naming Conventions

INPUTS		**OUTPUTS**	
Equipment	**Point Name**	**Equipment**	**Point Name**
Exhaust Fan Status	EF # Status	Exhaust Fan Control	EF # Control

.2 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.

1.2 RELATED WORK SPECIFIED ELSEWHERE

.1 Plumbing & Drainage
Ventilation & Air Conditioning
Testing & Balancing
HVAC System Commissioning
Electrical

.2 Supply all necessary efforts to provide the project DDC system as specified.

1.3 DESCRIPTION OF SYSTEM

.1 This is an upgrade and/or modification of an existing 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:

.1 Extension of the existing programmable building automation control (BAS) system

.2 Control and monitoring of indoor space temperature.

.3 Local/remote system control/monitoring via BACnet/IP TCP/IP Ethernet LAN/WAN connections

.4 AHU unit control.

.5 HV unit control.

.6 Building low temperature Low building temperature alarm (all spaces with sensor)

.7 Existing fan control

.8 Unit heater control

.9 All control valves, dampers, operators, etc, required under this contract

.10 All electric wiring, switches, relays, etc., for a complete operating system

.11 All wiring incidental to controls system

.12 System and equipment trending and scheduling

.13 System training

.4 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.

.5 All electrical wiring, mechanical installations, and control sequences shall comply with local and provincial electrical and mechanical codes.

.6 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 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.

1.5 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.

1.6 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).

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.

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.

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.

Acceptable material:
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 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.

3.5 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:

Facility layout (showing buildings, streets, etc.)
Individual area layouts or isometrics
Any other graphics necessary for logical penetration
Individual HVAC systems graphics
Sequences of operation
Flowcharts for critical DDC loops
Supervisor graphics
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

.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

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 KPRDSB 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 KPRDSB 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 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 humidities (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.

3.6 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 operator offset editable directly from the graphic screen

.9 weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon

.10 trend logs shall be accessible directly from the graphic by selecting an icon

.2 SF-5 CONSTANT VOLUME UNIT CONTROL WITH REMOTE VARIABLE FREQUENCY DRIVES & CIRCULATION PUMP (SF-6 SIMILAR)

.1 The air handling unit consists of a mixed air section with filter, hot water heating coil and pump, DX cooling coil (SF-5 Only) and supply fan. The unit is DDC controlled using electronic actuation. The supply fan is wired through their respective remote VFD’s interlocked through the BAS control. The dampers are controlled through the BAS system. The existing circulating pump(s) operates when the OA temperature is below 10 degrees C (ADJ).

.2 The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes. Within the Occupied mode, the system can enter the Warm-Up mode when the space temperature is below set point or the Cool-Down mode when the space temperature is above set point. The system stays in the Warm-Up or Cool-Down mode until the mode set point is satisfied. Within the Unoccupied mode, Night Heating is available when the space temperature drops below 65 degrees F (18 degrees C). The latest start time is the scheduled occupancy for the space.

.3 The air handling unit operates in Warm-Up, Cool-Down, Occupied, Unoccupied, Night Heating and Safety modes as follows (All suggested set points and settings are adjustable.):

Warm-Up

The supply fan starts. The mixing dampers are positioned for 100% return air. The 3-way heating valve(s) modulate to maintain the supply air temperature set point. If time reaches the latest start time during the Warm-Up mode, the outdoor air damper opens to its minimum position. The system is prevented from entering the Warm-Up mode more than once per day.

Cool-Down

The supply fan and return fan start. The heating valve remains closed to the coil. The mixing dampers, remote condensing unit (SF-5 only), and valves modulate to maintain the supply air temperature set point. When the outside air dry bulb temperature is above the economizer changeover value, the mixing dampers are positioned for 100% return air. If time reaches the latest start time during the Cool-Down mode, the outdoor air damper opens to its minimum position or is controlled in economizer operation. The system is prevented from entering the Cool-Down mode more than once per day.

Condensing unit Control is part of Itemized Price No. 3, refer to Division 1 specification section .

Unoccupied Mode

The supply fan is off and the mixing dampers are in the 100% recirculation position. The hydronic heating valve(s) are open to the coil.

Occupied Mode

An optimized start routine is provided. During morning warm-up or cool-down the outside air minimum position is set to zero. Supply and return fans run continuously. Supply air temperature discharge sensor operates the 3-way heating valve(s), and the mixing dampers (for mixed air temperature and/or free cooling) in sequence to maintain setpoint which is reset from outside air temperature as follows:

OAT	SAT
22ºC	13ºC
10ºC	18ºC

Room Sensor

A room sensor controls the space temperature and resets the discharge temperature sensor to maintain space temperatures.

A CO2 sensor in the return air stream shall override the mixing damper set point and modulate the dampers open upon sensing a rise in the return air CO2 level above the return air CO2 level set point.

Interlock SF-5 with existing exhaust fans EF-01 and EF-02.

.3 SF-1 (SF-2, SF-3, SF-4 SIMILAR) CONSTANT VOLUME UNIT CONTROL WITH REMOTE VARIABLE FREQUENCY DRIVES

.1 The air handling unit consists of a mixed air section, outdoor air and return air dampers, filter, face & bypass hot water heating coil, and supply fan. The unit is DDC controlled using electronic actuation. The supply fan is wired through a remote VFD interlocked through the BAS control. The dampers are controlled through the BAS system. Provide end of cycle (EOC) valve to close when unit is out of heating season.

.2 The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes. Within the Occupied mode, the system can enter the Warm-Up mode when the space temperature is below set point or the Cool-Down mode when the space temperature is above set point. The system stays in the Warm-Up or Cool-Down mode until the mode set point is satisfied. Within the Unoccupied mode, Night Heating is available when the space temperature drops below 65 degrees F (18 degrees C). The latest start time is the scheduled occupancy for the space.

.3 The air handling unit operates in Warm-Up, Cool-Down, Occupied, Unoccupied, Night Heating and Safety modes as follows (All suggested set points and settings are adjustable.):

Warm-Up

The supply fan starts. The mixing dampers are positioned for 100% return air. The face & bypass damper modulates to maintain the supply air temperature set point. If time reaches the latest start time during the Warm-Up mode, the outdoor air damper opens to its minimum position. The system is prevented from entering the Warm-Up mode more than once per day.

Cool-Down

The supply fan starts. The heating valve remains closed to the coil. The mixing dampers modulate to maintain the supply air temperature set point. When the outside air dry bulb temperature is above the economizer changeover value, the mixing dampers are positioned for 100% return air. If time reaches the latest start time during the Cool-Down mode, the outdoor air damper opens to its minimum position or is controlled in economizer operation. The system is prevented from entering the Cool-Down mode more than once per day.

Unoccupied Mode

The supply fan is off and the mixing dampers are in the 100% recirculation position. The hydronic heating valve is open to the coil.

Occupied Mode

An optimized start routine is provided. During morning warm-up or cool-down the outside air minimum position is set to zero. Supply fan runs continuously. Supply air temperature discharge sensor operates the 3-way heating valve, and the mixing dampers (for mixed air temperature and/or free cooling) in sequence to maintain setpoint which is reset from outside air temperature as follows:

OAT	SAT
22ºC	13ºC
10ºC	18ºC

Room Sensor

A room sensor controls the space temperature and resets the discharge temperature sensor to maintain space temperatures.

A CO2 sensor in the return air stream shall override the mixing damper set point and modulate the dampers open upon sensing a rise in the return air CO2 level above the return air CO2 level set point.

Space Pressurization

A pressure differential switch located where indicated modulates the outdoor air damper to maintain a room negative pressure in the space of +/- 0.06" wg.

.4 HV-1 UNIT CONTROL (HV-2 similar)

.1 General

Provide the following:

.1 Allowable start time.

.2 Stop time.

.3 Holiday operation.

.4 Purge cycle start time according to sensible free cooling control parameters.

.5 Min. On/Off delays.

.6 Monitor runtimes. Maintenance alarms/reports.

.7 The supply fan is wired through a remote VFD interlocked through the BAS control.

.2 Unoccupied Mode:

The supply fan is off; mixing dampers are in the 100% recirculation position. If space temperature drops below night set back setpoint, unit will start and run until the room temperature rises by 3C (100% recirculation).

.3 Occupied Mode:

The supply fan runs continuously. Supply air temperature sensor operates the gas valve and, the mixing dampers (for free cooling) in sequence to maintain a setpoint which is reset from return air temperature.

.4 Limits & Safeties:

.1 Supply air temperature reset shut down the fans and closed the outside air damper if the temperature leaving the heat exchanger falls below low limit set point. An alarm is generated at the BAS.

.2 A minimum position is provided for the outside damper during occupied periods.

.5 Dampers:

.1 PID damper modulation control. MAT.SP minimum.

.2 User based on set point.

.3 Fresh air minimum damper position upon start.

.4 Sensible temperature free cooling program.

.5 Fail closed, 100% return air.

.6 Heating:

.1 User based set points.

.7 Alarms:

.1 Provide complete digital/analog based on AIR HANDLING UNIT alarms.

.8 Space Pressurization:

.1 A pressure differential switch located where indicated modulates the outdoor air damper to maintain a room negative pressure in the space of +/- 0.06" wg.

.9 Space temperature:

.1 A room mounted sensor overrides the discharge controller to maintain space temperature.

Interlock HV-2 with existing NFPA hood & dishwasher hood exhaust fans

.10 When the kitchen exhaust fan is started through the stop start pushbutton mounted adjacent to the hood, the HV-2 unit is energized on proof of exhaust air flow. The stop/start pushbutton is existing.

.11 HV-2 unit maintains a discharge temperature ± 20°C (adj) through a duct mounted discharge sensor which modulates the gas valve (HV-2) to maintain setpoint.

.5 EXHAUST FANS

.1 Provide programmable start/stop control at the OWS.

.2 Provide dual voltage relays for exhaust fans rated for 120V/1/60. Install dual voltage relays in accessible ceiling space adjacent to exhaust fan.

.3 Wire through dual voltage relay or magnetic starters as indicated. Magnetic starters will be provided by Electrical Division.

.6 EXISTING CONTROL

.1 Provide new DDC control and components for the existing systems indicated

.1 Existing Roof Mounted Exhaust Fans.

.7 UNIT HEATER CONTROL

.1 A temperature sensor energizes the fan to maintain setpoint.

.8 RADIATION HEATING CONTROL

.1 A space temperature sensor operating through a DDC ASC shall modulate the incremental heating valve to maintain the space temperature setpoint.

.9 HVAC-1 CONSTANT VOLUME

.1 Fan Start-Stop Control

Optimum Start-Stop: The HVAC unit is started and stopped based on a time schedule which is adjusted by optimum start and stop calculations. The HVAC unit will start prior to occupancy time as determined by the optimum start calculation. The period between HVAC unit start and occupancy time is referred to as the pre-occupied period. At the end of this period, the occupied mode begins and continues until the HVAC unit is turned off. The HVAC unit may stop prior to the end of occupancy time as determined by the optimum stop calculation. If the outdoor air is less than 10°C, the system is in the heating mode. The optimum start and stop calculations will be based on heating parameters. When the system is not in the heating mode, the calculations will be based on cooling parameters.

Night Cycle: 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°.

Morning Warm-up: When the AHU 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 heating will stage on if the OA temperature is <13°C until the return air temperature exceeds warm-up mode setpoint. Cooling stages will be locked-out during the warm-up mode.

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.

Manual Override Timer: The supply fan will also be started if the manual override timer switch is activated. The fan will then run until the switch times out.

.2 Fan "OFF" Mode: The cooling and heating stages are disabled. The outdoor air and relief air dampers are fully closed and the return air damper is open. The bypass damper is open to bypass.

.3 Fan "ON" Mode, Room Temperature Control: The three way hearting valve and two DX cooling stages will be activated appropriately to maintain the supply air temperature at its setpoint.

Cooling Stages: As the space temperature rises above the setpoint, the first stage of cooling will energize for a minimum of 4 minutes (adj.). On a continued rise in room temperature, the first stage will remain on and if the minimum time between stages has elapsed (2 minutes), the second stage will energize for a minimum of 4 minutes (adj.). Cooling stages will remain energized until the cooling demand of the zone requirement is satisfied. When satisfied, the stages will de-energize in the reverse process. Once a stage is de-energized, it will remain off until the minimum off time has elapsed. The cooling minimum on, off and interstage times are separately configured from the heating stage times.

Heating Stages: As the space temperature falls below setpoint, the gas heating stages on to maintain a discharge temperature of 23°C for a minimum of 4 minutes (adjustable). On further drop in room temperature, the heating valve modulates to full open 32°C (adjustable). When the heating demand is satisfied, the heating valve will close in the reverse process. Once a stage is de-energized, it will remain off until the minimum off time has elapsed.

Economizer: The mixed air dampers and power exhaust will be under the control of the manufacturer. Provide mixed air sensor and power exhaust current sensing relay in HVAC unit.

.4 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.

.5 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.).

Similarly, while in the cooling mode with cooling stages on, an alarm will be generated whenever the discharge air temperature rises above or drops below the Discharge Air Temperature Cooling High or Low limits for a duration of 1 min (adj.).

.6 Fan System Failure Alarm: An alarm is generated whenever the supply fan fails to respond to start-stop commands.

.7 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.

.8 C02 Control: When a CO2 sensor mounted in the space and in the occupied time schedule, the respective HVAC unit outdoor air damper shall adjust open until the CO2 level is acceptable (one CO2 sensor per system).

CO2 setpoints shall be linear as follows:

.1 10% at 500 ppm

.2 40% (maximum) at 1200 ppm

.9 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%.

.10 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.

.10 ROOM VVT CONTROL

A room sensor provides local room control.

Ventilation Mode:
The VVT damper is normally held to a minimum of 80% airflow measured by the air flow sensor adjacent to each damper, in the ventilation mode as long as the supply air temperature from the unit is within the ventilation band of the room temperature. As the room temperature goes further off setpoint (heating/cooling) the demand signal broadcast to the rooftop unit increases to request heating or cooling.

Heating Mode:
If the temperature in an individual room falls below the room heating set point and modulate the heating valve, the damper modulates open 100% to anticipate a heating demand. All other zones will also be commanded open until the heating setpoint is exceeded. Above the setpoint the VVT dampers will modulate to a minimum position (30%) to prevent overheating and heating valve modulate close. The VVT dampers are returned to the minimum of 80% airflow when the room is satisfied.

Where a reheat coil and/or radiant panel is installed, on a call for heat, the temperature control valves are energized together and modulate to maintain room set point.

Cooling Mode:
If the temperature in an individual room rises above the room cooling set point and the rooftop is supplying cooling the damper modulates open 100% to anticipate a cooling demand. All other zones will also be commanded open until the cooling setpoint is satisfied. Below the setpoint the VVT dampers will modulate to a minimum position to prevent overcooling. The VVT damper is returned to the minimum of 80% airflow when the rooftop unit's supply air temperature increases to within 3ºC (adjustable) of the ventilation band of the room temperature.

Static pressure control: the bypass damper will be modulated to maintain the static pressure (0.5" WG adjustable) as its setpoint. Mount pressure sensor at 2/3 length of supply air duct.

Provide VVT system in graphic package by systems.

Provide a duct sensor in the VAV discharge duct.

<u>Safeties/Alarms</u>

If the zone temperature is above or below the alarm levels (adjustable), an alarm will be sent to the BAS.

.11 REHEAT COIL CONTROL

The space temperature sensor modulates the 2-way reheat coil heating valve to maintain setpoint. Provide setback setpoint for unoccupied periods. Provide min 10% flow for coil freeze protection.

Safeties/Alarms

If the zone temperature is above or below the alarm levels (adjustable), an alarm will be sent to the BAS

3.7 ELECTRICAL

.1 Rules and Regulations: The entire installation shall conform to Division 16 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 or 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.

3.8 RELIABLE 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.

AH # Start PG – contains all start stop parameters for the air handler.

AH # Setpoint PG – contains all setpoint calculations for the specific air handler.

AH # Control PG – contains all control points for the air handler for both occupied and unoccupied modes.

AH # Zone Setpoint PG – contains all setpoint calculations and limitations for zones serviced by the air handler.

AH # Zone Feedback PG – contains calculation of zone temperature averages, coldest and warmest spaces.

All Rooftop air handlers shall start with the letters RT in the naming conventions.

.2 Boilers, Pumps, and Hydronic Heating Systems Examples:

Heating Enable PG – contains all enable/disable calculations for the entire heating system.

Heating Setpoint PG – contains all setpoint calculations for scheduled water temperatures for both occupied and unoccupied periods.

Heating Control PG – contains control strategies for all heating equipment controlled from the panel.

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.

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			

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 Control
Glycol Return Water Temperature	Gly Return Temp			

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

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			

Network Status Panel Naming Conventions should indicate the school, panel location, and panel number. The school name can be abbreviated as necessary to fit the space.

3.9 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.

END OF WRITTEN SECTION

PLEASE REFER TO ATTACHED POINTS LIST

	Crestwood Secondary School						
CONTROL POINTS	DEVICE	DO	DI	AO	AI	Override Switch	Location
SF-5 Supply Fan Control	On/Off	1					Existing Fan Room 124
SF-5 Supply Fan Status	Amperage				1		Existing Fan Room 124
SF-5 DX Cooling (provide staged cooling)	2-10 VDC Control			4			Existing Fan Room 124
SF-5 3-way Heating Valve	2-10 VDC Control			1			Existing Fan Room 124
SF-5 Mixed Air Exhaust Dampers	2-10 VDC Control			1			Existing Fan Room 124
SF-5 Supply Air Sensor	Duct Temp Sensor				1		Existing Fan Room 124
SF-5 Return Air Sensor	Duct Temp Sensor				1		Existing Fan Room 124
SF-5 Mixed Sensor	Averaging Sensor				1		Existing Fan Room 124
SF-5 Freeze Stat Status	Duct Temp Sensor		1				Existing Fan Room 124
SF-5 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Fan Room 124
SF-5 Carbon Dioxide Sensor	Duct Sensor		1				Existing Fan Room 124
SF-5 Space Sensor (complete with override button)	Space Sensor				1		Verify on Site
SF-5 New Heating Coil Circulating Pump Control (P-101)	On/Off	1					Existing Fan Room 124
SF-5 New Heat Coil Circulating Pump Status (P-101)	Amperage				1		Existing Fan Room 124
Condensing Unit CU-5 Control (3 stages)	On/Off		3				Roof - Refer to Itemized Price
Condensing Unit CU-5 Status (3 stages)	Amperage				3		Roof - Refer to Itemized Price
SF-6 Supply Fan Control	On/Off	1					Existing Fan Room 124A
SF-6 Supply Fan Status	Amperage				1		Existing Fan Room 124A
SF-6 3-way Heating Valve	2-10 VDC Control			1			Existing Fan Room 124A
SF-6 Mixed Air Exhaust Dampers	2-10 VDC Control			1			Existing Fan Room 124A
SF-6 Supply Air Sensor	Duct Temp Sensor				1		Existing Fan Room 124A
SF-6 Return Air Sensor	Duct Temp Sensor				1		Existing Fan Room 124A
SF-6 Mixed Sensor	Averaging Sensor				1		Existing Fan Room 124A
SF-6 Freeze Stat Status	Duct Temp Sensor		1				Existing Fan Room 124A
SF-6 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Fan Room 124A
SF-6 Carbon Dioxide Sensor	Duct Sensor		1				Existing Fan Room 124A
SF-6 Space Sensor (complete with override button)	Space Sensor				1		Verify on Site
SF-6 New Heating Coil Circulating Pump Control (P-102)	On/Off	1					Existing Fan Room 124A
SF-6 New Heat Coil Circulating Pump Status (P-102)	Amperage				1		Existing Fan Room 124A
SF-4 Supply Fan Control	On/Off	1					Existing Electrical Shop
SF-4 Supply Fan Status	Amperage				1		Existing Electrical Shop
SF-4 3-way Heating Valve	2-10 VDC Control			1			Existing Electrical Shop
SF-4 Face & Bypass Dampers	2-10 VDC Control			1			Existing Electrical Shop
SF-4 Mixed Air Exhaust Dampers	2-10 VDC Control			1			Existing Electrical Shop
SF-4 Supply Air Sensor	Duct Temp Sensor				1		Existing Electrical Shop
RF-4 Return Air Sensor	Duct Temp Sensor				1		Existing Electrical Shop
SF-4 Mixed Sensor	Averaging Sensor				1		Existing Electrical Shop
SF-4 Freeze Stat Status	Duct Temp Sensor		1				Existing Electrical Shop
SF-4 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Electrical Shop
SF-4 Carbon Dioxide Sensor	Duct Sensor		1				Existing Electrical Shop
SF-4 Pressure Differential	2-10 VDC Control				1		Existing Electrical Shop
SF-4 Space Sensor (complete with override button)	Space Sensor				2		Existing Electrical Shop

	Crestwood Secondary School						
CONTROL POINTS	DEVICE	DO	DI	AO	AI	Override Switch	Location
SF-3 Supply Fan Control	On/Off	1					Existing Automotive Shop
SF-3 Supply Fan Status	Amperage				1		Existing Automotive Shop
SF-3 3-way Heating Valve	2-10 VDC Control			1			Existing Automotive Shop
SF-3 Face & Bypass Dampers	2-10 VDC Control			1			Existing Automotive Shop
SF-3 Mixed Air Exhaust Dampers	2-10 VDC Control			1			Existing Automotive Shop
SF-3 Supply Air Sensor	Duct Temp Sensor				1		Existing Automotive Shop
RF-3 Return Air Sensor	Duct Temp Sensor				1		Existing Automotive Shop
SF-3 Mixed Sensor	Averaging Sensor				1		Existing Automotive Shop
SF-3 Freeze Stat Status	Duct Temp Sensor		1				Existing Automotive Shop
SF-3 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Automotive Shop
SF-3 Carbon Dioxide Sensor	Duct Sensor		1				Existing Automotive Shop
SF-3 Space Sensor (complete with override button)	Space Sensor				2		Existing Automotive Shop
SF-3 Pressure Differential	2-10 VDC Control				1		Existing Automotive Shop
SF-2 Supply Fan Control	On/Off	1					Existing Computer Room
SF-2 Supply Fan Status	Amperage				1		Existing Computer Room
SF-2 3-way Heating Valve	2-10 VDC Control			1			Existing Computer Room
SF-2 Face & Bypass Dampers	2-10 VDC Control			1			Existing Computer Room
SF-2 Mixed Air Exhaust Dampers	2-10 VDC Control			1			Existing Computer Room
SF-2 Supply Air Sensor	Duct Temp Sensor				1		Existing Computer Room
SF-2 Return Air Sensor	Duct Temp Sensor				1		Existing Computer Room
SF-2 Mixed Sensor	Averaging Sensor				1		Existing Computer Room
SF-2 Freeze Stat Status	Duct Temp Sensor		1				Existing Computer Room
SF-2 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Computer Room
SF-2 Carbon Dioxide Sensor	Duct Sensor		1				Existing Computer Room
SF-2 Space Sensor (complete with override button)	Space Sensor				2		Existing Computer Room
SF-2 Pressure Differential	2-10 VDC Control				1		Existing Computer Room
SF-1 Supply Fan Control	On/Off	1					Existing Wood Shop
SF-1 Supply Fan Status	Amperage				1		Existing Wood Shop
SF-1 3-way Heating Valve	2-10 VDC Control			1			Existing Wood Shop
SF-1 Face & Bypass Dampers	2-10 VDC Control			1			Existing Wood Shop
SF-1 Mixed Air Exhaust Dampers	2-10 VDC Control			1			Existing Wood Shop
SF-1 Supply Air Sensor	Duct Temp Sensor				1		Existing Wood Shop
SF-1 Return Air Sensor	Duct Temp Sensor				1		Existing Wood Shop
SF-1 Mixed Sensor	Averaging Sensor				1		Existing Wood Shop
SF-1 Freeze Stat Status	Duct Temp Sensor		1				Existing Wood Shop
SF-1 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Wood Shop
SF-1 Carbon Dioxide Sensor	Duct Sensor		1				Existing Wood Shop
SF-1 Pressure Differential	2-10 VDC Control				1		Existing Wood Shop
SF-1 Space Sensor (complete with override button)	Space Sensor				1		Existing Wood Shop

	Crestwood Secondary School						
CONTROL POINTS	DEVICE	DO	DI	AO	AI	Override Switch	Location
HV-1 Supply Fan Control	On/Off	1					Roof - Refer to Itemized Price
HV-1 Supply Fan Status	Amperage				1		Roof - Refer to Itemized Price
HV-1 Gas Heating Valve (modulating)	2-10 VDC Control			1			Roof - Refer to Itemized Price
HV-1 Freeze Stat Status	Duct Temp Sensor		1				Roof - Refer to Itemized Price
HV-1 Mixed Air Damper	2-10 VDC Control			1			Roof - Refer to Itemized Price
HV-1 Supply Air Sensor	Duct Temp Sensor				1		Roof - Refer to Itemized Price
HV-1 Pressure Differential	2-10 VDC Control				1		Machine Shop - Refer to Itemized Price
HV-1 Space Sensor (complete with override button)	Space Sensor				1		Machine Shop - Refer to Itemized Price
HV-1 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Existing Corridor Mezzannine Mech Room
HV-2 Supply Fan Control	On/Off	1					Roof
HV-2 Supply Fan Status	Amperage				1		Roof
HV-2 Gas Heating Valve (modulating)	2-10 VDC Control			1			Roof
HV-2 Freeze Stat Status	Duct Temp Sensor		1				Roof
HV-2 Mixed Air Damper	2-10 VDC Control			1			Roof
HV-2 Supply Air Sensor	Duct Temp Sensor				1		Roof
HV-2 Pressure Differential	2-10 VDC Control				1		Kitchen
HV-2 Space Sensor (complete with override button)	Space Sensor				1		Kitchen
HV-2 Supply Fan Variable Frequency Drive	2-10 VDC Control			1			Kitchen
HVAC-1 Supply Fan Control	On/Off	1					Roof - Refer to Itemized Price
HVAC-1 Supply Fan Status	Amperage				1		Roof - Refer to Itemized Price
HVAC-1 DX Cooling (provide staged control)	2-10 VDC Control	4					Roof - Refer to Itemized Price
HVAC-1 Gas Heating (provide staged control)	2-10 VDC Control			3			Roof - Refer to Itemized Price
HVAC-1 Supply Air Sensor	Duct Temp Sensor				1		Roof - Refer to Itemized Price
HVAC-1 Return Air Sensor	Duct Temp Sensor				1		Roof - Refer to Itemized Price
HVAC-1 Mixed Air Sensor	Duct Temp Sensor				1		Roof - Refer to Itemized Price
HVAC-1 Freeze Stat Status	Duct Temp Sensor		1				Roof - Refer to Itemized Price
HVAC-1 Gas Valve (Provide 3 Stage)	2-10 VDC Control			3			Roof - Refer to Itemized Price
HVAC-1 Carbon Dioxide Sensor	2-10 VDC Control			1			Refer to Plan - Refer to Itemized Price
Exhaust Fan Control	On/Off	2					Refer To Plan - Wire Thru DVR/Starter
Exhaust Fan Status	Amperage				2		Refer To Plan - Wire Thru DVR/Starter
VVT Control	2-10 VDC Control			2			Final Count to be Determined on Site
VVT Discharge Temperature	Duct Sensor			2			Final Count to be Determined on Site
Space Temperature	Space Temp Sensor				2		Final Count to be Determined on Site
Unit Heater Control	On/Off	1					Refer to Plan
Unit Heater Status	Amperage				1		Refer to Plan
Unit Heater Space Sensor	Space Sensor				1		Refer to Plan
Reheat Coil Discharge Temperature	Duct Sensor			2			Refer to Plan - Part of Itemized Price
Reheat Coil 3-way Valve	2-10 VDC Control			2			Refer to Plan - Part of Itemized Price
Space Temperature	Space Temp Sensor				2		Refer to Plan - Part of Itemized Price
Radiation Heating Valve(s)	2-10 VDC Control			1			Final Count to be Determined on Site
Space Temperature	Space Temp Sensor				1		Final Count to be Determined on Site