



REGIONAL DISTRICT OF NANAIMO – DASHWOOD FIRE HALL REPLACEMENT

MECHANICAL SPECIFICATION

Issued for Tender – July 22, 2022

PROJECT NO.: 145A-004-20

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Permit to Practice No:
1000236



2022-07-22

PROFESSIONAL'S SEAL & SIGNATURE

| Section No. | Section Title |
|--------------------|---|
| 21 05 01 | Common Work Results for Mechanical |
| 21 05 02 | Fire Suppression Systems |
| 22 05 02 | Plumbing and Drainage |
| 22 07 11 | Fire Stopping |
| 23 05 01 | Acceptable Manufacturers |
| 23 05 02 | Heating, Ventilation and Air Conditioning |
| 23 23 00 | Refrigerant Piping |
| 23 34 01 | Emergency Vehicle exhaust system |
| 23 81 29 | Variable Refrigerant Flow HVAC Systems |
| 25 05 00 | Common Work Results for Integrated Automation |

1. GENERAL

1.1 Section Scope

- .1 This Section specifies general conditions for Divisions 21, 22, 23 and 25 and is to be read, interpreted, and coordinated with all other sections.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings and General Provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections apply to work specified in this section.
- .3 Section 25 05 00 – Common Works Results for Integrated Automation.

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 British Columbia Codes:
 - .1 British Columbia Building Code [2018] (BCBC).
 - .2 British Columbia Fire Code [2018].
 - .3 British Columbia Plumbing Code [2018].
 - .4 Technical Safety BC regulations and regulatory notices.
- .3 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE 90.1- [16], Energy Standard for Buildings except Low-Rise Residential Buildings.
 - .2 ASHRAE 62.1-[01], Ventilation for Acceptable Indoor Air Quality.
 - .3 ASHRAE 62.1-07, Ventilation for Acceptable Indoor Air Quality.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .5 Electrical Equipment Manufacturers' Association Council (EEMAC):

1.4 Definitions

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.

- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.
- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant
- .8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS", and "DDC" generally mean same.
- .9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.
- .10 "OSHA" and "OHS" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .11 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .12 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .13 "Consultant" – means person, firm, corporation identified as such in Agreement, or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.5 General Scope

- .1 The scope of Section 21 Fire Suppression, Section 22 Plumbing, Section 23 HVAC, and Section 25 Control is for building services within the project structure and 1m from the building.
- .2 Provide complete, fully tested, and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.
- .3 Contract documents and drawings of this Division are diagrammatic and approximately, to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.

- .4 Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.
 - .5 Install equipment generally in locations and routes indicated. Run piping and ductwork close to building structure, parallel to building lines, maximize headroom and maintain minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost.
 - .6 For work within existing facilities, confirm locations and elevations of existing piping and equipment prior to commencement of new work.
 - .7 Install equipment to provide service access, maintain service clearances and for ease of maintenance.
 - .8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start up and test.
- 1.6 Install control valves, control dampers, thermal wells, and other devices on piping and ductwork, furnished by Division 25. Coordination of Work**
- .1 Cooperate and coordinate with other trades on the project.
 - .2 Make reference to electrical, mechanical, structural, and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.
 - .3 Where dimensional details are required, work with the applicable architectural and structural drawings.
 - .4 Full size and detailed drawings shall take precedence over scale measurements from drawings.
 - .5 Any areas indicated as space for future materials or equipment shall be left clear.
- 1.7 Permits and Fees**
- .1 All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.
 - .2 Obtain all permits and pay all fees applicable to the scope of work.
 - .3 Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.
- 1.8 Examination of Site**
- .1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of tender.
- 1.9 Tender Price Breakdown**
- .1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format agreed to with the Consultant.

- .2 As a minimum, include the following in the tender price breakdown:
 - .1 Site Services: Materials, labour
 - .2 Mechanical: Equipment, materials, labour
 - .3 Plumbing: Equipment, materials, labour
 - .4 Sheet Metal: Equipment, materials, labour
 - .5 Fire protection: Equipment, materials, labour
 - .6 Controls: Equipment, materials, labour

1.10 Submittals

- .1 Submittals shall be in accordance with Division 01 - Submittal Procedures, Division 01 – Closeout Procedures, Division 01 – Closeout Submittals and the following:
 - .1 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Consultant.
 - .2 No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
 - .3 Shop drawings shall be reviewed by the General Contractor and Mechanical Sub-Contractor indicating that the shop drawings have been reviewed, coordinated with the work and that the shop drawings are submitted without qualifications. Shop drawings shall bear the 'reviewed' stamp dated and initialled by the General Contractor and Mechanical Sub-Contractor prior to submitting the shop drawings to the consultant. Shop drawings, which do not bear the contractors and sub-trades 'reviewed' stamp, initials and date will be rejected and sent back as 'not reviewed'.
 - .4 Submit samples, in addition to drawings, of all items, which in the Consultant's judgment, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.
 - .5 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert to the specified product and manufacturer for this project.
- .2 Contractor shall provide and submit to the Consultant Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional Schedule S-B and Assurance of Professional Field Review and Compliance by Supporting Registered Professional Schedule S-C for seismic engineering.
- .3 Contractor shall provide and submit to the Consultant Assurance of Professional Design and Commitment for Field Review Schedule B and Assurance of Professional Field Review and Compliance Schedule C-B for fire protection engineering.
- .4 Requirements for Contractor Retained Engineers
 - .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
 - .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned

- consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
- .3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:
 - .1 Coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - .2 Insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - .3 Liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work.
 - .4 Retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above.
 - .5 Evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.
 - .5 Submit shop drawings for all products identified in the relevant specification sections of Divisions 21, 22, 23 and 25. Provide drawings as electronic files (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
 - .6 Submit the following shop drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .1 Fastening details for Seismic restraints.
 - .2 Mounting details for spring isolation of equipment.
 - .3 Sprinkler drawings including hydraulic calculations as per NFPA.
 - .7 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 Capacity and performance characteristics indicated on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification for compliance to applicable codes.
 - .8 Shop drawings to indicate:
 - .1 Material Specification including CSA or ULC reference numbers.
 - .2 Clearly mark submittal material using arrows, underlining or circling to show differences from specified ratings, capabilities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps, seals, material, or painting.
 - .3 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with mounting point loads.
 - .4 Weights of all major equipment for review by the appropriate Consultant.
 - .5 Mounting arrangements and installation details to suit the applications on this project.
 - .6 Motor efficiencies on motors 1H.P. and larger.

- .7 List of the manufacturers and figure numbers for all valves, traps and strainers.
- .8 Control explanation and internal wiring diagrams for packaged equipment.
- .9 Control system drawings including a written description of control sequences relating to the schematic diagrams. Refer to additional requirements in controls sections.
- .10 Operating and maintenance requirements.
- .11 Submit as a shop drawing, an electrical equipment list for any equipment supplied by the mechanical contractor or his subtrades. The list is to be submitted in a timely fashion so that the electrical contractor can utilize the list as a final check prior to ordering motor control centres, starters, or disconnects. The list is to indicate the following:
 - .1 The horsepower size and number of motors.
 - .2 The minimum circuit amps (MCA) for packaged equipment such as roof top units.
 - .3 The voltage and phase of the motors.
 - .4 Whether or not a starter or a disconnect is included as part of the package.
- .9 Material Safety Data Sheets (MSDS):
 - .1 Submit Material Safety Data Sheets (MSDS) in accordance with Division 01 - Submittal Procedures for the following products. Indicate VOC emissions, prior to installation or use:
 - .1 Adhesives.
 - .2 Caulking compounds.
 - .3 Sealants.
 - .4 Insulating materials.
 - .5 Fireproofing or fire stopping materials.
- .10 Closeout Submittals:
 - .1 Provide mechanical operation and maintenance data in compliance with Division 01 - Closeout Submittals and the following:
 - .1 The Contractor shall furnish and pay for three (3) complete sets of operating and maintenance manuals for the complete mechanical installation plus two (2) copies of the digital version of the manuals on USB type flash drive.
 - .2 Supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - .1 Front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
 - .2 Introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 Equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 Copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers,

- email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
- .3 Operation and maintenance manual approved by, and final copies deposited with the Consultant a minimum of 7-days before final inspection.
 - .4 Operation data to include but not limited to:
 - .1 Pressure test reports, and certificates issued by governing authorities
 - .2 Control schematics for systems including environmental controls.
 - .3 Wiring and connection diagrams.
 - .4 A description of the systems and associated controls.
 - .5 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .6 Operational instructions for systems and associated components.
 - .7 A description of actions to be taken in the event of equipment failure.
 - .8 Valves schedule and flow diagrams.
 - .9 Colour coding chart.
 - .5 Maintenance data to include:
 - .1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .3 Recommended maintenance practices and precautions.
 - .4 Complete parts lists with numbers.
 - .6 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets indicating point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results and final commissioning report.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting, and balancing.
 - .7 Digital Version of Manuals
 - .1 The digital version of the manuals and the hard copy version shall be prepared by the same company.
 - .2 Utilize latest version of Adobe Acrobat, Portable Document Format (pdf).
 - .3 The digital manual shall be enhanced with the following features: Bookmarks, Internet Links, Internal Documents Links and Optical Character Recognition (OCR).
 - .4 All shop drawings shall be scanned to a minimum 8.5" x 11" size. If the original page is 11" x 17", the digital copy shall also be 11" x 17".

- .5 Provide a minimum 300 DPI for all scanned pages.
- .6 All scanned material may be searched for text with minimum 60% Optical Character Recognition (OCR).
- .7 Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.
- .8 Digital manual shall be organized in the same manner as the hard copy manual. Bookmark all major tabs and sub-sections and each set of shop drawings. Link the Table of Contents to the referenced section. Insert Internet Links to the Mechanical Equipment Manufacturers/Suppliers/Contractors official websites
- .8 Approvals:
 - .1 Submit 1 copy of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .9 Warranties
 - .1 Include copy of all equipment warranty and extended warranty certificates into the Operation and Maintenance Manual.
- .10 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need as it becomes apparent during demonstrations and instructions.
 - .2 Chemical treatment reports.
 - .3 Back-flow preventer test certificates.
 - .4 Results of Owner's Orientation (demonstrations).
 - .5 List of spare parts turned over to owner's forces.
- .2 Site records:
 - .1 Contractor shall maintain 1 set of white prints at contractors cost to mark changes as work progresses and as changes occur.
 - .2 Use different colour waterproof ink for each service. Do not use pencil or black ink.
 - .3 Transfer information weekly to show work as actually installed.
 - .4 Make available for reference purposes and inspection.
 - .5 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
- .3 Record drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for Mechanical, finalize production of record drawings.
 - .2 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant

- .3 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
- .4 Submit to Consultant for approval and make corrections as directed.
- .5 Perform testing, adjusting and balancing for HVAC using record drawings.
- .6 Submit completed reproducible record drawings with Operating and Maintenance Manuals.
- .7 Cost to transfer record information onto reproducible media & Auto-CAD are this contractor's responsibility. Consultant will release drawings to contractor after signing a copyright form.
- .8 Should the Contractor choose to utilise this consultant for transferring as built information, allow \$400 / sheet for all drawings in the construction set. This will cover costs for drafting time & printing costs.
- .9 Submit copies of record drawings for inclusion in final testing and balancing report.
- .10 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.

1.11 Spare Parts Submittals

- .1 Furnish spare parts in accordance with Division 01 - Closeout Submittals and as follows:
 - .1 One set of packings for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One set of V-belts for each piece of machinery.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Additional spare parts shall also be included as outlined in their appropriate sections.
- .3 Provide one set of special tools if required to service equipment as recommended by manufacturers.

1.12 Quality of Work

- .1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Consultant.
- .2 Work, which does not conform to standards accepted by the Consultant and the trade, may be rejected by the Consultant. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.13 Metric Conversion

- .1 All units in this division are expressed in SI units.
- .2 Submit all shop drawings and maintenance manuals in SI units.
- .3 On all submittals (shop drawings etc.), use the same SI units as stated in the specification.

- .4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:
- .1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment, and piping.
 - .2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

| Equivalent Nominal Diameter Of Pipes | | | | | |
|--------------------------------------|--------------|-----|--------------|-----|--------------|
| mm | inches (NPS) | mm | inches (NPS) | mm | inches (NPS) |
| 3 | 1/8 | 40 | 1-1/2 | 200 | 8 |
| 6 | 1/4 | 50 | 2 | 250 | 10 |
| 10 | 3/8 | 65 | 2-1/2 | 300 | 12 |
| 15 | 1/2 | 75 | 3 | 375 | 15 |
| 20 | 3/4 | 100 | 4 | 450 | 18 |
| 25 | 1 | 125 | 5 | 500 | 20 |
| 30 | 1-1/4 | 150 | 6 | 600 | 24 |

- .5 Metric Duct Sizes:
- .1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.14 Drawings and Specifications

- .1 Drawings and specifications are complementary to each other, and what is called for by one shall be binding as if called for by both.
- .2 Should any discrepancy appear between drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of the plans, and specifications, obtain written clarification from the Consultant during the tender period. Without a written clarification, the better quality and/or greater quantity of work or materials shall be estimated, performed and furnished within the tendered price.
- .3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.15 Cutting, Patching and Coring

- .1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.
- .2 Drill for expansion bolts, hanger rods, brackets, and supports.
- .3 Perform x-rays and obtain written approval from the Structural Consultant before cutting or burning structural members. Use of Ground Penetration Radar (GPR) method to locate concealed electrical conduit, structural re-bar, post-tension cables, etc. is also acceptable.
- .4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field cut smaller than 100 mm.

- .5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.
- .6 Removal of any existing pipe, conduit, or ductwork within a slab core hole or slab opening through floors and roofs must be removed completely, including any associated sleeving, in a safe manner. Provisions are to be made during the removal process to protect any occupants and/or fabric of the space below. The Consultant is to be advised of all existing mechanical service penetration locations, such that site visits and field reviews can be fully co-ordinated and undertaken before and after the opening is closed in and filled.
- .7 Filling of any existing slab core or opening is to be with an engineered design of concrete fill complete with doweling for adhesion and/or fire stopping system as appropriate.

1.16 Excavation and Backfill

- .1 Refer to the requirements of Division 31.
- .2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.
- .3 Refer to drawing details as applicable.

1.17 Installation of Equipment

- .1 Pipe all equipment drains to building drains except systems containing glycol.
- .2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.
- .3 Maintain permanent access to equipment for maintenance.

1.18 Equipment and Materials

- .1 Materials and equipment installed shall be new, CSA approved and of quality specified.
- .2 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.
- .3 Where two or more products of the same type are required, products shall be of the same manufacturer.
- .4 Notify the Consultant in writing ten (10) days prior to the tender close, any materials or equipment specified which is not currently available or will not be available for use as called for herein. Failing this, the contract will assume that the most expensive alternate has been included in the tender price.
- .5 All equipment supplied to the project will meet efficiencies as defined in ASHRAE Standard 90.1 and NECB (current versions).

1.19 Pressure Piping

- .1 For regulations for the design registration, under specific requirements, of pressure piping systems and components that convey an expansible fluid or non-expansible fluid between two points refer to Technical Safety BC

1.20 Cleaning

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 Clean equipment and devices installed as part of this project.

1.21 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance with Division 01 - Common Product Requirements, the manufacturer's written instructions and the following:
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials and equipment in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping, equipment and duct systems.
- .5 Protect equipment and open-end duct with polyethylene covers and maintain equipment on crates until installation.
- .6 Operate, drain and flush out unsealed bearings and refill with fresh oil before final acceptance.
- .7 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
- .8 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
- .9 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.
- .10 Packaging Waste Management
 - .1 Remove for reuse and return pallets, crates, padding, packaging materials etc. as specified in the Construction Waste Management Plan or Waste Reduction Work plan in accordance with Division 01 - Waste Management and Disposal and Division 01 - LEED Requirements.

1.22 Fire Stopping and Smoke Seals

- .1 Provide fire stopping and smoke seals in accordance with Division 07 – Fire Stopping and Section 22 07 11. If the requirements for fire stopping of mechanical services penetrations of Section 22 07 11 differ from the requirements of Division 07, the most stringent requirements shall apply.

1.23 Access Doors

- .1 General
 - .1 Provide access doors for maintenance or adjustment of all parts of the mechanical system. This shall apply but not be limited to valves, dampers, cleanouts and controls.
 - .2 Where equipment is concealed by a T-bar ceiling, the location of equipment shall be indicated by coloured markings. Refer to Section 23 05 53 Identification for Mechanical Piping and Equipment.
 - .3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.
 - .4 Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms.
 - .5 Provide Drywall type access doors in all public drywall spaces requiring access to equipment.
 - .6 All fasteners on access panels shall be tamper proof, contractor shall provide three (3) sets of keys.
 - .7 Locate all access doors outside of secure areas where possible. Where not possible, review the locations of panels with the Owner's Consultant prior to installation. All access panels within secure areas are to be of penal quality, lockable, vandal-proof and ligature resistant.
 - .8 Provide 300 mm x 300 mm minimum size for inspection and hand access.
 - .9 600 mm x 600 mm minimum size, larger if indicated on drawings, where entry is required and access is difficult.
 - .10 Size to suit masonry modules when located in a masonry wall.
 - .11 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface material and pattern if this is available at the time the units are ordered.
 - .12 Security Access Doors:
 - .1 Access doors for security areas shall be 1.70 mm [14 gauge] thick double skinned internally reinforced at 150 mm [6"] on centre, 4.76 mm [3/16"] thick, insulated in pressed sink wiped cold rolled steel metal frame (similar to door frame) complete with necessary preparation to receive security lock escutcheon and hinges.
- .2 Submittals:
 - .1 Submit shop drawings for all access doors anticipated on this project.

1.24 Single Point Electrical Connection

- .1 If the equipment is indicated on the schedules or within the motor list (both included in the mechanical drawings) as a single point connection, the equipment shall be provided with all integral HOA type starters, internal wiring to all motors, starters, lighting, service outlets etc. such that a single electrical connection can be utilized to power all

components within the unit. The unit shall also incorporate the required step-down transformers and wiring to connect all of these internal components including controls wiring. Coordinate with the controls subcontractor for the supply, installation, and wiring of control components.

1.25 Electrical Motors

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Quality Assurance
 - .1 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be UL listed and CSA labelled.
 - .2 All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.
 - .3 All motors intended for use with a [variable speed drive] [variable frequency drive] (VFD) shall be inverter duty rated.
 - .4 Motors connected to VFD(s) shall be wound using inverter spike resistant magnet wire capable of 1600V.
 - .5 The noise level of each motor shall comply with NEMA standards, less than 80 dBA at 1 meter.
 - .6 Minimum certified motor efficiency shall be as outlined in current version of ASHRAE 90.1 and NECB.
- .3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.
- .4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.
- .5 Motors less than 3/4-hp shall be 120 V, 60 Hz, 1 phase. Motors 3/4-hp and larger shall be 3 phase at the indicated voltage.
- .6 All motors shall be 1800 rpm unless otherwise noted.
- .7 Provide motors complete with equipment except where indicated.
- .8 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
- .9 Provide motors designed with Class B insulation, Class F insulation for totally enclosed motors.
- .10 Motors exposed to outdoor temperature to be lubricated with lubricants suitable for operation at 6 deg. C. below the lowest temperature recorded by ASHRAE or the Climatic Information (Supplement to the National Building Code), for the location in which they are installed.
- .11 All motors 10 hp and larger that are controlled by a VFD are to use a dielectric grease bearings and a grounding kit with a system of brass or stainless steel brushings.

- .12 Refer to electrical specifications, Section 26 05 81 - Motors, for voltage, frequency, and phase data. This shall take precedence over any reference in Divisions 21, 22, 23 and 25.
- .13 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.
- .14 All motors used with fire pumps shall be listed for fire pump service.
- .15 Submittals
 - .1 Submit data of test method used and motor efficiencies with shop drawings.

1.26 Motor Starters and Accessories

- .1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.
- .2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt; thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.
- .3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .4 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .5 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.
- .9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:

- .1 Enclosures located in sprinklered areas – Type 2;
- .2 Enclosures exposed to the elements – Type 3R, constructed of stainless steel;
- .3 Enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
- .4 Enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
- .5 Enclosures except as noted above – Type 1;
- .6 Enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.

- .10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, freestanding motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.

- .11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.

- .12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.

1.27 Miscellaneous Metals

- .1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for work under this contract.
- .2 All miscellaneous metals shall be prime painted.
- .3 Miscellaneous metals shall include but not limited to:
 - .1 Hangers for equipment, piping and ductwork.
 - .2 Support for equipment.
 - .3 Access platforms and catwalks.

1.28 Scaffolding, Hoisting and Rigging

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner.
- .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner.

1.29 Pipe Sleeves

- .1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum schedule 40 steel pipes or factory fabricated, flanged, high-density polyethylene sleeves with reinforced nail bosses. Sleeves shall extend 25 mm on either side of the wall.
- .2 Schedule 40 steel pipes shall be used as floor pipe sleeves in wet areas with a 50 mm up-stand.
- .3 Review and coordinate sleeve diameters with fire stop installation details as applicable.
- .4 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.30 Water Proofing Materials

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

1.31 Escutcheons and Plates

- .1 Provide escutcheons and plates on all piping and ductwork passing through finished walls, floors and ceilings.
- .2 Escutcheons shall be one piece, stainless or chrome plated steel.

1.32 Temporary Heat

- .1 Do not use the permanent system for temporary heating purposes without written permission from the Consultant.
- .2 If approved, permanent mechanical systems in building may be used for temporary heating during construction subject the following conditions:
 - .1 Each entire system is complete, pressure tested, cleaned, and flushed out.
 - .2 Specified water treatment system has been commissioned, and treatment is being continuously monitored.
 - .3 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged worn or damaged parts before final inspection.
 - .4 Use of permanent systems for temporary heat shall not modify terms of warranty.
 - .5 Operate heating systems under conditions, which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.
 - .6 Air systems shall not be used for temporary heating.
 - .7 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company system.

- .8 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.
- .9 Energy costs are to be paid by Contractor.
- .10 During this period of construction, such systems/equipment to not become property of Owner or be Owner's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turn over to Owner.
- .11 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Owner, such systems/equipment to be cleaned, restored to "new" condition, paint finishes "touched-up", filters cleaned or replaced, etc.

1.33 Progress Claim Breakdown

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.
- .4 Progress claims will not be certified nor payment made beyond 95% on the overall Mechanical contract and beyond 70% on the Control systems contract, until commissioning and verification of the systems are complete. (The 70% limit on Controls is included in the overall fig.). This procedure is to allow for any necessary deficiency holdbacks on items, which do not become apparent until the systems are commissioned.

1.34 Notice for Required Field Reviews

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.35 Changes in the Work

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation being proposed cost for executing change or revision.

- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .4 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.36 Temporary or Trial Usage

- .1 Temporary or trial usage by the Owner or Consultant of mechanical equipment supplied under contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.
- .4 Avoid thermal shock to heating system by coordination with the Owner during planning, construction and operation of temporary heating system.

1.37 Instruction to Owner

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel, on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - .2 Troubleshooting – diagnostic instructions, test and inspection procedures;
 - .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
 - .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
 - .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.

- .5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from Owner a list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 Date instructions were given to Owner's staff;
 - .2 Duration of instruction;
 - .3 Names of persons instructed;
 - .4 Other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.

1.38 Guarantee / Warranty

- .1 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work, which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.
- .2 Use of permanent systems for temporary heat shall not modify terms of the manufacturers' warranty or the guarantee.
- .3 If the equipment is used during construction, the warranty or guarantee period shall not be shortened or altered.

1.39 Substantial and Total Performance

- .1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items, which are deficient.
- .2 A certificate of Substantial Performance will not be granted unless the following items are completed and available to the Owner's Consultant:
 - .1 Final Plumbing Inspection Certificate from the Authority having Jurisdiction.
 - .2 Schedule C-B for Fire Suppression.
 - .3 Fire Sprinkler Materials and Test Certificate.
 - .4 Fire alarm test certificate (via DIV.26).
 - .5 Schedule S-C for seismic engineering.
 - .6 Final Backflow Prevention test reports for all backflow devices.
 - .7 Commissioning checklists are completed and submitted as per Division 01.
 - .8 Fire stopping and Fire Damper test letter.
 - .9 Vibration isolation supplier's inspection report.
 - .10 Systems have been chemically cleaned. Flushed and water treatment initiated. Provide report from manufacturer's representative to confirm status of treatment and final inspection.

- .11 Potable water piping's flushing and chlorination test certificate
 - .12 Major equipment – suppliers start-up test sheets and letters certifying start up (Boilers, chillers, packaged equipment).
 - .13 Draft Operating/Maintenance Manuals have been submitted for review.
 - .14 All mechanical systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation.
 - .15 Air and water systems have been balanced with draft report submitted to the Consultant.
 - .16 Mechanical identification is complete.
 - .17 Warranty forms have been mailed to the manufacturer. Provide copy of the original warranty for equipment, which has a warranty period longer than one year.
 - .18 Operating and Maintenance demonstrations have been provided to the Owner.
 - .19 Written inspection report by manufacturer's representative has been submitted for noise and vibration control devices and flexible connections.
 - .20 Record drawings have been submitted.
 - .21 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.
 - .22 All previously identified deficiencies have been corrected and accepted.
 - .23 Heat trace megger test reports for each circuit, submitted on manufacturer's letterhead.
- .3 Prior to a Total Performance Inspection, provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:
- .1 Submit final air and water balance reports.
 - .2 Submit final operating and maintenance manuals.
 - .3 Complete final calibration.
- .4 The Consultant shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.
- .5 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.40 Alternate Materials and Equipment

- .1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.
- .2 Requests for alternate equivalent materials or equipment must be submitted to the Consultant no later than seven (7) working days prior to the Mechanical trades' closing tender date. Submit all applicable technical data, including performance curves and physical details for review. Approval of requests shall only be given by addendum.
- .3 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.
- .4 The Contractor shall be fully responsible for any additional labour and materials required by any trades or other Contractors to accommodate the use of other than specified materials or equipment. The Contractor shall bear any and all costs for design/system

modifications to accommodate the "alternate" equipment. Extras will not be approved to cover such work.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 Acceptable Manufacturers.

2.2 Core Drilling

- .1 Clearly identify all proposed piping penetrations through existing slabs, walls etc. and advise the General Contractor. Obtain x-rays or GPR scanning of the locations to ensure penetration will avoid any existing post tension cables or reinforced steel. Advise the Structural Consultant of any conflicts as a result of the x-rays or GPR scans and obtain the Structural Consultant approval before any coring take place.

2.3 Fire Stopping and Smoke Seals

- .1 Provide fire-stopping materials as per Division 07 and Section 22 07 11 Fire Stopping.

2.4 Access Doors

- .1 Drywall Surface: Extruded aluminum frame with gypsum board inlay and structural corner elements. Hinge to be concealed 2-point hinge, non-corroding with screwdriver operated cam latch.
- .2 Masonry Surface: Universal design, steel door (16ga) and steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .3 Tile Surface: Universal design, stainless steel door (16ga) and stainless steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, screwdriver operated cam latch, #4 satin stainless steel finish.
- .4 Plaster Walls and Ceiling: steel door (14ga) and steel frame (14ga), door flush to frame edge, expansion casing bead and 75 mm wide galvanized lath surround recessed 18 mm to receive plaster, continuous concealed hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .5 Acoustic Plaster: Steel door (16ga) and steel frame (14ga), door recessed 12 mm lined with self-furring lath, 75 mm wide galvanized lath surround recessed 18 mm to receive plaster flush to frame edge, concealed pivoting rod type hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .6 Acoustical Tile Ceilings: Steel door (16ga) and steel frame (14ga), door recessed 25 mm to receive acoustic tile, concealed pivoting rod type hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .7 Fire Rated Walls:
 - .1 Non-combustible construction: Uninsulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 2 hour 'B' label.

- .2 Combustible construction: Insulated steel door (20ga) for maximum 250°C rise after 30 minutes and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 1-1/2 hour 'B' label.
- .8 Fire Rated Ceilings: 50mm Insulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed upswing self-closing hinge, L handle latch, white baked enamel finish, size 600mm x 600mm (24" x 24") ULC rated 2 hour 'B' label.
- .9 Ductwork: Ultra low leakage type, flat oval design, galvanized steel frame (22ga), double skin galvanized steel door (22 ga) with 25mm insulation fully enclosed in panel, bulb type seal integrally fastened to door, lever cam locks. Provide stainless steel in lieu of galvanized steel in stainless steel ductwork.

2.5 Electrical Motors

- .1 All Motors, 1 H.P. motors and larger, shall be energy efficient design and have a minimum and nominal full load efficiency, which will meet or exceed the values listed in accordance CAN/CSA C390-1. The minimum efficiency shall be guaranteed.
- .2 Belt Drives: Provide belt drives to the following requirements:
 - .1 Provide steel, cast iron or aluminum sheaves for motors less than 3/4 H.P.
 - .2 Provide steel or cast iron sheaves keyed to shafts, for motors 3/4 H.P. and larger.
 - .3 For motors less than 10 H.P. provide standard adjustable pitch drive sheaves having +/-10% range. Use mid-position of range for specified RPM.
 - .4 For motors 10 H.P. and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.
 - .5 Match drive and driven sheaves.
 - .6 V-belts shall conform to the American Belt Manufacturers standards. Multiple belts shall be matched sets.
 - .7 Not less than a 2-belt configuration is required for each drive for motors 3/4 H.P. and larger.
 - .8 Poly Chain GT belt drives shall be used on all motors 10HP and larger.
 - .9 Minimum drive rating shall be 150% of nameplate rating of motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
 - .10 Motor slide rail adjustment baseplate with double draw bolt, shall allow for centre line adjustment.
 - .11 Tension belts to manufacturers recommendations before start up and after 100 hours of operation using calibrated belt tensioning gauge.
 - .12 Provide one spare set of belts for each piece of equipment with each belt separately identified for the equipment item to be served.
- .3 Shaft Couplings: Shaft couplings shall be of the pin or jaw neoprene insert type, gear type, or flexing steel insert type and shall allow coupling inserts to be easily removed without disassembly of the equipment.
- .4 Guards:
 - .1 Provide removable protective guards on all exposed V-belt drives and shaft couplings in accordance with Worker's Compensation Board requirements.

- .2 Guards for drives shall have:
 - .1 1 mm [18ga.] expanded metal screen welded to 25 mm [1"] steel angle frame.
 - .2 1.5 mm [16ga.] thick galvanized sheet metal tops and bottoms.
 - .3 Removable side[s] for servicing.
 - .4 38 mm [1-1/2"] dia. holes on both shaft centres for insertion of tachometer.
 - .5 Sectionalize if necessary so one man can handle removal.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Fabricate and install belt guards for V-belt drives to permit movement of motors for adjusting belt tension and for belt slap.
- .5 Provide removable "U" shaped guards for flexible couplings with 2.5 mm [12ga.] thick galvanized frame and 1.2 mm [18ga.] thick expanded mesh face.
- .6 Provide guards on all unprotected fan inlets and outlets. Guards to be provided by fan manufacturer.
- .7 Prime coat guards and finish paint to match equipment.
- .8 Secure guards to equipment allowing for ease of removal.

3. EXECUTION

3.1 Painting Repairs and Restoration

- .1 Do painting in accordance with Division 09 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.
- .4 Clean exposed bare metal surfaces supplied under Divisions 21, 22, 23 and 25. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.
- .5 Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer.

3.2 System Cleaning

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

3.3 Field Quality Control

- .1 Manufacturer's Field Services:
 - .1 Obtain written reports from manufacturers' verifying compliance of the work, in handling, installing, applying, protecting, cleaning and start-up of a product.
 - .2 Submit Manufacturer's Field Reports as described in PART 1 - Submittals.
 - .3 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.4 Demonstration

- .1 Consultant and/or Owners representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct the operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Where specified elsewhere in Division 21, 22, 23 or 25 manufacturers to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, record drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration requirements shall be as specified in the appropriate sections.
- .6 Contractor will record these demonstrations on digital video for future reference.

3.5 Fire Stopping and Smoke Seals

- .1 Refer to Section 22 07 11.

3.6 Access Doors

- .1 Installation:
 - .1 Provide all access doors required to access work installed by Divisions 21, 22, 23 and 25. Be responsible for coordinating locations, cutting opening and installing panels. Any secondary supports, blocking etc. will be by the ceiling or wall contractor.
 - .2 Access doors in mechanical equipment to be provided by this Division.
 - .3 Access panel requirements and locations shall be fully coordinated with all involved contractors prior to the installation of any mechanical systems or equipment.
- .2 Location:
 - .1 Ensure that equipment is within view and accessible for operating, inspecting, adjusting, servicing without using special tools.
- .3 Provide 3 sets of each type of access door key to the Owner at substantial completion. Obtain a signed receipt indicating date, quantity of keys and person receiving keys. Submit receipt to the Owner's Consultant.

3.7 Electrical Motors

- .1 Manufacturer's instructions:
 - .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .2 Installation:
 - .1 Unless otherwise noted starters and protection devices will be included under Division 26 - Electrical.

- .2 Co-ordinate with Division 26 Contractor to ensure proper connection, correct thermal overload protection and correct motor controls.
 - .3 Where starters are included in this Division as an integral part of packaged equipment, they shall contain thermal overload protection in all ungrounded lines.
 - .4 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch.
 - .5 Fasten securely in place.
 - .6 Make removable for servicing, easily returned into, and positively in position.
 - .3 Setting and Alignment:
 - .1 Employ a journeyman millwright to align all V-belt drives and/or shaft coupling drives. The millwright shall check that centrifugal fan wheels are properly centred on fan shafts.
 - .2 Align shaft couplings, using a dial indicator, to within +/-0.051 mm [0.002"] after grouting is complete and the piping system is operational.
 - .3 Align V-belt drives using a straight edge.
 - .4 Submit a certificate from the millwright employed, certifying that all shaft couplings and V-belt drives have been aligned and centrifugal fan wheels centred prior to initial start-up and checked again after final system balance adjustment.
- 3.8 Protection**
- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 This is a performance specification for the provision of all labour and materials necessary to install a complete and ready for continuous operation, fire suppression system for this project. The systems shall be as indicated in the contract documents and as required by the referenced codes and the Authority having jurisdiction.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts. For general conditions, refer to Section 23 05 02 Heating, Ventilation, and Air Conditioning.

1.3 Code Compliance

- .1 All work shall comply with current editions of the National, Provincial and Municipal Codes, Standards, Acts and Bylaws and will meet the requirements of the Authority having jurisdiction.

1.4 Submittals

- .1 Comply with Division 1 – Submission and Closeout Procedures and in addition the following:
- .2 Provide Consultant Assurance of Professional Design and Commitment for Field Review Schedule B and Assurance of Professional Field Review and Compliance Schedule C-B for fire suppression systems.
- .3 Shop drawings: Provide a minimum of four (4) sets of the following stamped and signed by a Professional Engineer registered or licensed in Province of British Columbia:
 - .1 Hydraulic calculations for sprinkler design.
 - .2 Detailed piping and sprinkler head layouts.
 - .3 Manufacturer's catalog data including specific model and size for all equipment.
- .4 Extra Materials:
 - .1 Provide spare sprinklers and tools as required by NFPA 13.

1.5 General Requirements

- .1 The fire suppression contractor shall retain the services of a Professional Engineer registered in the Province of British Columbia (Fire Suppression Engineer) to provide complete engineering design and field review services including signed and sealed CAD fire suppression drawings and hydraulic calculations.
- .2 The fire suppression system information shown on the drawings is diagrammatic. The Sprinkler Contractor shall prepare fabrication/working drawings for all the sprinkler work, pay all associated fees and obtain all approvals from the Authorities having jurisdiction prior to installation. Where sprinkler head locations are shown, this is to indicate general intent only. It is the responsibility of the contractor to allow in his bid and to install all heads and piping required to satisfy the code. No extra cost will be considered based on failure of the contractor to allow for sprinklers as required during construction to conform to all NFPA requirements and the Authority Having Jurisdiction, whether shown on the drawings or not.
- .3 Provide all fire suppression systems throughout the area of the building indicated on the contract drawings including:

- .1 Wet sprinkler systems in all heated areas
 - .2 Dry sprinklers in all exterior and unheated areas including underground and covered parking levels, loading areas, attics, un-heated concealed spaces, balconies etc.
 - .3 Portable fire extinguishers
 - .4 Commercial kitchen exhaust hood suppression systems
 - .5 Paint spray booth fire suppression systems
- .4 Submit all documentation to the Authorities Having Jurisdiction, arrange for, pay for, and obtain trade permits prior to commencing installation work on site. All inspections and tests required by the Authorities shall be arranged and paid for by this contractor.
 - .5 Provide all testing, adjusting and balancing; commissioning; identification; insulation; and heat tracing for all fire suppression systems as described in the associated specification Sections and required by the applicable codes and Authority having Jurisdiction.

1.6 Engineering Design Requirements

- .1 Design systems for earthquake protection for buildings in seismic zone.
- .2 Design system in accordance with ANSI/NFPA 13, using the following parameters:
 - .1 In the absence of requirements from the Authority having jurisdiction:
 - .1 Utilize pipe schedule method for areas less than 278m² (3000SF).
 - .2 Pipe Schedule or Hydraulic calculations for areas 278m² (3000SF) or greater.
 - .3 Hydraulic calculation for areas greater than 929m² (10,000SF).

1.7 Substantial & Total Performance

- .1 A certificate of Substantial Performance will not be granted unless the Fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

2. PRODUCTS

2.1 General

- .1 All materials shall be ULC Listed for the intended service and shall be supplied in original factory packaging.
- .2 Piping, valves, and sprinkler types shall match the base building standard.
- .3 All sprinklers shall be to ANSI/NFPA 13 and ULC listed for fire services.
- .4 All sprinklers shall be for commercial applications unless stated otherwise. Residential sprinklers are only permitted in residential areas of residential buildings.
- .5 Provide firestopping.

2.2 Pipe, Fittings and Couplings

- .1 Provide for all pipe, fittings, couplings, valves, nipples, drains, test connections, and all accessory pipe work for a complete installation within the base tender price.

- .2 No extra cost will be considered based on failure of the contractor to allow for pipe, fittings and pipe work as required during construction to provide offsets to avoid structural components, and to coordinate with other piping services, ductwork, cable trays, conduits or other obstacles whether indicated on the drawings or not.
- .3 All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- .4 Provide one piece escutcheon plates for piping passing through walls, floors, and ceilings in exposed spaces.
- .5 All exposed sprinkler pipes shall be copper piping painted.

2.3 Valves

- .1 Test and Drain Valves - 1210 kPa (175 psi) - ULC listed
 - .1 NPS 1 to NPS 2: Cast bronze construction, tapped gauge outlet, and integral sight glass.
 - .2 NPS 1 and NPS 1-1/4: Forged brass construction, tapped 6 mm (1/4") gauge outlet, and integral sight glass.

2.4 Sprinklers

- .1 All sprinklers shall be to ANSI/NFPA 13 and ULC listed for fire service.
- .2 Wrenches shall be provided by the sprinkler manufacturer that directly engage the hex-shaped wrench boss in the sprinkler body.
- .3 Sprinklers with rubber O-rings are not permitted.
- .4 All sprinklers in exposed areas subject to viewing by the building occupants shall be chrome plated finish with matching escutcheons. All sprinklers in service spaces, mechanical and electrical rooms and other spaces subject to view by the maintenance staff of the building may be in natural plain brass finish.
- .5 Provide dry upright, dry pendant or dry sidewall sprinklers as required to serve areas subject to freezing served from wet sprinkler system piping.
- .6 The finished escutcheon shall not project more than 4 mm (1/4") below the finish ceiling surface. The escutcheons shall match the sprinkler finish, be of the same manufacturer as the sprinkler and shall coordinate with architectural features of the building.
- .7 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.5 Flow Switches

- .1 Provide 24V DC with both normally open and normally closed contacts, time delay and paddle indicator. Switch to be ULC listed for pipe size the flow switch is mounted on.
- .2 Provide test and drain assembly immediately downstream of each flow switch in addition to normal inspector's test connections required by NFPA 13 requirements.
- .3 Flow switches shall be manufactured specifically for use in sprinkler systems.
- .4 Rated working pressure 1210 kPa (175 psi).
- .5 Flow switches installed in hazardous locations shall be listed for use in hazardous locations.

2.6 Pressure Switches

- .1 24V DC pressure switch, ULC listed.
- .2 Rated working pressure 1210 kPa (175 psi).
- .3 Pressure switches installed in hazardous locations shall be listed for use in hazardous locations.

2.7 Supervisory Switches

- .1 24V DC supervisory switches, ULC listed complete with 1 set of normally open contacts and 1 set of normally closed contacts or 2 sets of SPDT contacts.
- .2 Looped cable devices are not acceptable.
- .3 Approved valves with integral and/or factory installed indicators and supervisory controls are acceptable products.
- .4 Supervisory switches installed in hazardous locations shall be listed for use in hazardous locations.

2.8 Backflow Prevention Stations

- .1 Provide a ULC Listed double check valve assembly (DCVA) complete with O.S. & Y. inlet and outlet shut-off valves.
- .2 Provide a ULC Listed reduce pressure backflow assembly (RPBA) complete with O.S. & Y. inlet and outlet shut-off valves for glycol systems.
- .3 Backflow prevention stations shall be in complete accordance with the manual "Cross Connection Control Manual" published by the Pacific Northwest Section of the American Water Works Association.
- .4 Isolation valves shall be provided with supervisory switches connected to supervisory signals at the fire alarm system.
- .5 Provisions for forward flow testing of backflow preventer in compliance with NFPA 13 shall be provided.

2.9 Air Compressor

- .1 Automatic air compressor listed for use with dry pipe fire protection sprinkler systems.
 - .1 UL listed motor and pressure switch.
 - .2 ASME rated air receiver tank and safety valve.
 - .3 Control kit for automatic stop/start operation.
- .2 Capacity to restore normal air pressure in system within 30 minutes and to provide air pressure of 140 kPa in excess of calculated trip pressure of dry pipe valve, in accordance with instruction sheet furnished with dry pipe valve.

2.10 Fire Department Connection

- .1 Flush mounted fire department inlet connections at location indicated on drawings:

- .1 Flush mounted fire department inlet connection, cast brass body, double 64 mm [2½"] clapper valves, 2 - 64 mm [2½"] inlet ports with brass plugs and chains, 100 mm [4"] outlet, integral ball drip. Storz or threaded connections to suit requirements of Fire Department.
- .2 Wall escutcheon plate 380 mm x 229 mm [15" x 9"] marked with 25 mm [1"] high raised letters "AUTO SPRINKLER".
- .2 At the low point near each fire department connection, install a 90 degree elbow with drain connection to allow for system drainage to prevent freezing.
- .3 For combined sprinkler/standpipe systems label escutcheon plate AUTO SPRINK/STANDPIPE.
- .4 High pressure and low pressure zones shall be clearly labelled with respective pressure ratings.

2.11 Spare Sprinklers

- .1 Provide a red baked enamel steel cabinet in location designated or located adjacent to alarm valves for storage of maintenance materials, spare sprinkler heads, and special tools.
- .2 Provide a minimum of two (2) spare sprinklers heads of each type and temperature rating used on the Project, but in addition, not less than the following of total spare sprinklers:

| Number of Sprinklers | Total Spares |
|----------------------|--------------|
| Up to 300 | 6 minimum |
| 300 – 1000 | 12 minimum |
| Over 1000 | 24 minimum |

- .3 Provide suitable wrenches for each sprinkler type.
- .4 Provide a list of the sprinklers installed in the property, posted in the sprinkler cabinet to NFPA 13.

2.12 Fire Stopping

- .1 Materials, accessories, and application procedures listed by ULC cUL, or tested in accordance with CAN/ULC-S115 to comply with building code requirements.
- .2 Fire stopping Materials: CAN/ULC-S101 ASTM E119 ASTM E814 to achieve a fire rating as noted on Drawings.
- .3 Surface Burning: CAN/ULC-S102 ASTM E84 with a flame spread/smoke developed rating of 25/50.
- .4 Installer shall be certified, licensed, or otherwise qualified by the fire stopping manufacturer as having the necessary training to install the manufacturer's products to specified requirements. On request, the certified installer shall provide documented proof of certification from the firestop system manufacturer. A manufacturer's willingness to sell its firestop products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

3. EXECUTION

3.1 Installation

- .1 For underground piping comply with AWWA C600 – Installation of Ductile Iron Water Mains

- .2 Polyvinyl chloride (PVC) piping used for underground water supply lines shall adapt to approved non-plastic material prior to penetration through the exterior building wall or floor slab.
- .3 PVC systems shall be installed to the Manufacturers listing limitations.
- .4 Provide thrust blocks and tie rods on all underground sections of piping.
- .5 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.
- .6 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.
- .7 Flush all underground water mains and fire department connection lines before connecting to the fire suppression systems.
- .8 Install equipment in accordance with manufacturer's instructions.
- .9 Install approved monitored valves and flow switches for all zones. Monitored valves and flow switches shall be wired to central fire alarm system by Division 26. Identify each valve by indicating which zone is controlled by each valve. Ensure devices are connected as required to the fire alarm system. Coordinate with Division 26.
- .10 Install spare parts cabinet in location designated or located adjacent to alarm valves. Coordinate with owner and consultant.
- .11 Adjust sprinkler piping up or down if conflicts occur between structure, lighting, electrical, plumbing piping or ductwork.
- .12 Provide expansion joints or flexible couplings at building expansion joints, [building earthquake joints], building firewalls, and other locations as required.
- .13 All grooved end components including valves, fittings, and couplings shall be of one manufacturer.
- .14 Run sprinkler piping in heated joist spaces to avoid bulkheads. Coordinate with structural for any drilling – coring of joist.
- .15 Flush entire piping system until effluent is clear and free of debris. Minimum flush time of 2 hours. Rate of flushing flows shall be as indicated in NFPA-13.

3.2 Isolation Valves

- .1 Install isolation valves whether shown on the drawings or not at the following locations:
 - .1 At the base of each standpipe riser.
 - .2 At each sprinkler zone.
 - .3 At all points where required by the Building Codes, By-Laws or NFPA

3.3 Backflow Prevention Stations

- .1 Install backflow prevention stations in complete accordance with the "Cross Connection Control Manual" published by the Pacific Northwest Section of the American Water works Association. Mount backflow preventers at maximum 1.5 metres (5 ft.) above finished floor.
- .2 Complete testing of all backflow prevention devices shall be carried out under this section of the work prior to final acceptance of the fire suppression systems. Submit a certificate duly signed and witnessed that testing was satisfactorily completed and include a copy in the project Mechanical Operation and Maintenance Manual.

3.4 Backflow Prevention Station Forward Flow Test

- .1 Provide means to forward flow test backflow preventer in compliance with the requirements of NFPA 13.

- .2 Discharge from forward flow test shall be to an acceptable location.
- .3 Flow meters for forward flow test:
 - .1 Install flow meters in compliance with manufacturer's recommendations.
 - .2 Location of flow meter shall allow for ease of reading and the installation in the piping system shall allow for the recommended upstream and downstream pipe diameters from valves and fittings.

3.5 Electrical Equipment Protection from Water

- .1 Responsibility for water damage to electrical equipment from the sprinkler system installation whether due to testing or leakage prior to the Owner's acceptance of the building shall be the responsibility of this Section.

3.6 Field Quality Control

- .1 The Fire Suppression Engineer shall perform all field services as required to fulfil the Building Code obligation for the provision of the Assurance of Professional Field Review and Compliance Schedule C-B for fire suppression systems and seismic restraint of fire suppression systems.
- .2 The Fire Suppression Engineer shall provide field reviews on a monthly basis (minimum) throughout the duration of the project. Submit concise field reports to the Owner's Consultant within 3 days of each site review.
- .3 Allow for destructive testing of 5% of fire stopping applications. Should installations not conform to manufacturer's listed assembly, an additional 25% of installations may be destructively tested and should there be more failures, the contractor will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the project.
- .4 Firestopping shop drawings shall be on site at all times to provide reference for the consultant, Engineer of record and building authorities.

3.7 Testing

- .1 Test sprinkler systems to NFPA listed requirements and furnish a certificate stating that such testing has been carried out and approved. Tests shall be witnessed by the authority having jurisdiction or his designated alternate.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Piping, valves and specialties serving building water distribution systems to 1m (36") outside the building.
- .2 Sanitary and storm drain waste and vent piping, equipment and accessories between plumbing fixtures to 1m (36") from the building.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts. For general conditions, refer to Section 23 05 02 Heating, Ventilation, and Air Conditioning.

1.3 Code Compliance

- .1 All work shall comply with current editions of the National, Provincial and Municipal Plumbing Codes, Standards, Acts and Bylaws and will meet the requirements of the Authority having jurisdiction.

1.4 Cleanouts

- .1 Provide cleanouts on all sanitary and storm drainage piping at all changes in direction, at the ends of all horizontal runs, at the base of every stack, where drains leave the building; where shown on the drawings and in compliance with the local plumbing code, bylaws and ordinances.
- .2 Provide caulked or threaded type cleanouts extended to finished floor wall surface.
- .3 Provide bolted cover plate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.

2. PRODUCTS

2.1 Piping

- .1 Pipe Material
 - .1 Sanitary and Storm Drainage, and Vent (above grade).
 - .1 DWV Copper
 - .2 Cast Iron Class 4000
 - .3 PVC-15 Schedule 40
 - .4 PVC-15XFR Schedule 40.
 - .2 Sanitary and Storm Drainage and Vent (below grade inside building to 1m outside).
 - .1 Cast Iron Class 4000
 - .2 PVC-DWV Schedule 40
 - .3 ABS-DWV (Solid Core) Schedule 40.
 - .3 Sanitary and Storm Drain (below grade outside service).
 - .1 Cast Iron Class 4000
 - .2 PVC SDR-35 to 12 NPS

- .3 Concrete over 12 NPS.
- .4 Domestic Water (above grade inside building).
 - .1 Pipe: Type 'K' hard drawn seamless copper tubing to ASTM B88 or copper pipe to ASTM B42.
 - .1 Fittings:
 - .1 Cast brass or wrought copper solder joint pressure fittings with 95/5 Sn/Sb or Silvabrite 100 solder joints.
 - .2 Press to Connect Fittings [12 mm (1/2" to 50 mm (2"))]:
 - .1 Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117 (IAPMO PS 117 is not for B75). Sealing elements shall be EPDM.
 - .2 Press ends shall allow identification of an unpressed fitting during pressure testing to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
 - .3 Pressing tools and jaws used shall be approved for use by the fitting manufacturer.
 - .3 Push to Connect Fittings [1/2 mm (1/2") to 50 mm (2"))]:
 - .1 Suitable for use with copper tubing and certified to NSF/ANSI 61, NSF/ANSI 14 and ASSE 1061 for use with potable water.
 - .2 Lead free DZR brass body, EPDM O-ring, stainless steel grab ring.
 - .3 Push to connect fittings shall be removable and create strong permanent joints. Fittings shall allow for easy removal after installation.
 - .2 High density crosslinked polyethylene pipe (PEX-a) 1 NPS and smaller to ASTM F876, ASTM F877, ASTM F1960 and CSA B137.5. All PEX tubing, fittings and fitting assemblies shall be by one manufacturer. CAN/ULC S102.2 listed for flame spread and smoke developed rating of 25/50.
 - .1 Pre-sleeved PEX-a tubing:
 - .1 NSF 61 certified high density polyethylene (HDPE) corrugated pre-sleeved tubing for use in PEX-a hot and cold potable water distribution systems for installation in concrete slabs or soil to allow removal and replacement of the tubing.
 - .3 Ductile iron water pipe and fittings inside the building to conform to C151/A21.51, cement mortar lining to conform to ANSI/AWWA C104/A21.4 and rubber gasket joints conforming to ANSI/AWWA C111/A21.11, Grade 'M' flush seal gaskets to ANSI/NSF 61. Fittings to conform to ANSI/AWWA C606 and CSA B-05.
 - .5 Domestic Water (below grade inside building to 1m outside).
 - .1 Type "K" Soft Copper to 4 NPS diameter
 - .2 PVC C900 DR18 from 4 NPS to 12 NPS (adapt to approved non-plastic material prior to penetration through the floor slab.

- .6 Domestic Water Service (below grade, outside service).
 - .1 Type "K" Soft Copper
 - .2 PVC C900 DR18 from 4 NPS to 12 NPS.
- .7 Natural Gas; Propane:
 - .1 Steel Schedule 40, A53 Grade B.
- .8 Compressed Air:
 - .1 Type "L" Hard Copper
 - .2 Steel Schedule 40, A120.
- .9 Equipment drains and overflows:
 - .1 Steel Schedule 40, Galvanized, A120.

2.2 Valves

- .1 General:
 - .1 Wherever possible all valves shall be of one manufacturer.
 - .2 Grooved valves shall be of the same manufacturer as the adjoining couplings.
 - .3 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body. All valves must be suitable in all respects for service used.
 - .4 All valves shall have a Provincial CRN number, which is current.
 - .5 Use non-rising stem valves only where there is insufficient clearance for stem to rise.
- .2 Ball Valves 2 NPS and under
 - .1 Low lead forged brass body, 2 piece body, full port, chrome plated ball, PTFE seats, blow out proof stem, adjustable packing nut, for domestic water service.
 - .2 Class 4140 kPa (600 psi) W.O.G.
 - .1 Soldered: Toyo/Red & White 5544DAB or equal.
 - .2 Screwed: Toyo/Red & White 5549DAB or equal.
- .3 Gate Valves 2 NPS and under:
 - .1 Lead free bronze body, solid wedge disc, bronze or stainless steel trim, non-rising stem, for domestic water service.
 - .2 Class 1380 kPa (200 psi) W.O.G.
 - .1 Soldered: Toyo/Red & White 207AB or equal.
 - .2 Screwed: Toyo/Red & White 206AB or equal.
- .4 Gate Valves 2½ NPS and over:
 - .1 Cast iron body, solid wedge disc, bronze or stainless steel trim, rising stem, outside screw and yoke complying with MSS SP 70
 - .2 Class 1380 kPa (200 psi) W.O.G.
 - .1 Flanged: Toyo/Red & White 421 or equal.
- .5 Globe Valves 2 NPS and under:
 - .1 Lead free bronze body, swivel type stainless steel disc, union bonnet, for domestic water service.
 - .2 Class 1380 kPa (200 psi) W.O.G.

- .1 Screwed: Toyo/Red & White 211AB or equal.
- .6 Check Valves 2 NPS and smaller:
 - .1 Lead free bronze swing check with bronze disc capable of being reground, Y pattern, suitable for domestic water use.
 - .2 Class 1380 kPa (200 psi) W.O.G.
 - .1 Soldered: Toyo/Red & White 237AB or equal.
 - .2 Screwed: Toyo/Red & White 236AB or equal.
- .7 Automatic Flow Limiting Balancing Valves
 - .1 Automatic flow control valve cartridges shall automatically control flow rates with $\pm 5\%$ accuracy over an operating pressure differential range of 410 kPa with a start up at 14 kPa or less.
 - .2 Body: brass rated at 600 WOG; cartridge: stainless steel; piston: stainless steel; spring: stainless steel; O-ring: EPDM; diaphragm: EPDM.
 - .3 The stainless steel cartridge shall be non-clog type that allows debris to be flushed through the body and eliminate particle accumulation and blockage at the outlet orifices. Cartridges manufactured with composite, plastic or tuber materials will not be allowed.
 - .4 Operating temperature: -20°C to 120°C ; control range: 14 kPa to 516 kPa.
 - .5 Griswold Controls K-valve

2.3 Plumbing Piping Specialties

- .1 Circuit Setter Valve: (for domestic hot water recirculation)
 - .1 1 1/4 NPS and smaller, soldered or screwed:
 - .2 1 1/2 NPS to 3 NPS, screwed:
 - .1 Lead free brass, regulating valve suitable for potable water, combination P/T test points with EPT inserts/check valves, drain port, memory stop handle with graduated markings, positive shut off, 1035 kPa @ 93°C (150 psi @ 200°F) rating.
- .2 Vacuum Relief Valve: (for hot water tanks installations)
 - .1 1/2 - 3/4 NPT, low profile, all brass construction, protective cap, tested to ANSI Z21.22, CSA certified, 860 kPa (125 psi) rating, maximum temperature 121°C (250°F).
- .3 Pressure Reducing Valve:
 - .1 1 NPS and smaller:
 - .1 Lead free copper silicon alloy body or low lead bronze body, SS integral strainer, renewable SS seat, serviceable inline, built in bypass check valve, suitable for hot and cold water potable water. Rated at maximum inlet pressure of 2100 kPa (305 psi) and 82°C (180°F) temperature.
 - .2 1 1/4 NPS to 2 NPS screwed ends:
 - .3 2 1/2 NPS and larger flanged ends:
 - .1 Pilot operated with low flow bypass, diaphragm actuated globe valve, lead free, bronze body, or ductile iron to ASTM A536. Lead free bronze, stainless steel, or ductile iron internals. All ductile iron components including body and cover shall be lined and coated with epoxy coating.

- .2 3 NPS and smaller: copper/brass pilot control, pilot strainer, pressure reducing pilot.
- .3 4 NPS and larger: copper and brass pilot control, external Y strainer, ball valve isolation on body connections
- .4 Pressure reducing pilot pressure 2100 kPa (30-200 psi)
- .4 Backflow Preventers Double Check Valve Assembly (DCVA)
 - .1 2 NPS and smaller, lead free cast copper silicone alloy body, twin positive seat check modules, captured springs, replaceable check module seats and discs, two isolation valves, test cocks and a bronze strainer. Comply with CSA B64.5 and AWWA C510
 - .1 Maximum working pressure: 1206 kPa (175 psi)
 - .2 Watts LF007 or equal
 - .2 2½ NPS and larger, FDA approved epoxy coated cast iron body, lead free design, twin positive seat check modules, captured springs, replaceable stainless steel check module seats and discs, two OS&Y isolation valves, test cocks and a strainer. Comply with CSA B64.5 and AWWA C510
 - .1 Maximum working pressure: 1206 kPa (175 psi)
 - .2 Watts LF709 or equal
- .5 Reduced Pressure Backflow Assembly (RPBA)
 - .1 2 NPS and smaller, lead free cast copper silicone alloy body, pressure differential relief valve, replaceable check module seats, and discs, two isolation valves, test cocks and a strainer. Comply with CSA B64.4 and AWWA C511.
 - .1 Maximum working pressure: 1206 kPa (175 psi)
 - .2 Watts LF009 or equal
 - .2 2½ NPS and larger, FDA approved epoxy coated cast iron body, lead free design, pressure differential relief valve, replaceable stainless steel seats, stainless steel internals, two OS&Y isolation valves, test cocks and a strainer. Comply with CSA B64.4 and AWWA C511
 - .1 Maximum working pressure: 1206 kPa (175 psi)
 - .2 Watts LF909 or equal
- .6 Strainers
 - .1 ¼ - 2 NPS threaded ends, bronze body, 1034 kPa (150 psi) rating.
 - .2 2½ NPS and larger, flanged ends, cast iron body, 860 kPa (125 psi) rating.
 - .3 With copper grooved end pipe systems use bronze body grooved end Y-strainer with stainless steel screen, 2068 kPa (300 psi) rating.
- .7 Water Hammer Arrestors
 - .1 Bellows type with welded stainless steel nesting bellows or piston style and stainless steel casing.
 - .2 Air chambers are unacceptable.

2.4 Preformed Pipe Insulation

- .1 Low to Intermediate Temperature, 5°C to 315°C (41°F to 599°F)

- .1 Preformed insulation, fine fibrous glass or formed mineral fibre pipe insulation with all service jacket vapour retarder (ASJ). ASJ shall be re-enforced with glass fibre, factory applied with pressure sensitive lap closure. Maximum "K" value at 38°C (100°F) = 0.035 W/m.°C (0.24 Btu.in/hr.ft2.°F)
- .2 Finish Jackets
 - .1 Thermocanvas Jacket: fire rated, 170g (6 oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.
 - .2 PVC Finishing Jacket: white, UV resistant, for indoor or outdoor applications, 25/50 fire class, minimum 0.50 mm (0.02") thick.
 - .3 Aluminum Jacket: 0.51 mm (22 ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm (2") end laps with factory applied protective liner on interior surface.

2.5 Cleanouts

- .1 Floor - Unfinished Area: Cast iron floor level cleanout assembly with extra heavy duty, round, adjustable, scoriated, secured cast iron top and no-hub outlet. Suitable for heavy traffic
- .2 Floor - Finished Area:
 - .1 General areas: Cast iron cleanout with extra heavy duty round, adjustable, scoriated, secured nickel bronze top, and no-hub outlet
 - .2 Foot traffic areas with sheet goods flooring: Cast iron floor level cleanout assembly with a square adjustable nickel bronze top with 6mm (1/8") tile recess, and no-hub outlet.
 - .3 Carpeted floor area subject to foot traffic: Cast iron floor level cleanout assembly with round, adjustable, scoriated, nickel bronze top, and carpet clamping frame.
- .3 Wall – Finished Area:
 - .1 Concealed drainage line in a finished wall: Cast iron cleanout tee and cast iron countersunk plug with stainless steel round cover and screw.

2.6 Floor Drains

- .1 Provide trap seal priming connections on all drains
- .2 Finished Area Drains
 - .1 Floor Drain "FD-1" (washroom, shower)
 - .1 Heavy duty polished nickel bronze round strainer, 125mm (5") diameter
 - .2 Floor Drain "FFD-1" (hub floor drain)
 - .1 Heavy duty coated cast iron adjustable round hub funnel, 125mm (5") diameter

2.7 Trench Drains

2.8 Trap Seal Primers

- .1 Provide flow actuated type priming device, vacuum breaker ports and internal back-flow protection, lead free brass body, stainless steel screen, factory pre-set, activation by a minimum flow rate of 0.03l/s @ 138 kPa (0.5 GPM @ 20 psi). 1/2 NPS inlet and outlet, capable of serving 1 to 4 traps.
- .2 Provide a timer / solenoid activated priming system.

- .1 Solenoid: ½ NPT Slow closing solenoid valve, forged brass body, Buna "N" disc, stainless steel parts, enclosure to suit environmental conditions, UL and CSA approved, 120 volt.
- .2 Provide ½ NPT globe valve upstream of the solenoid valve for throttling.
- .3 Provide a relay and building automation system interface. Coordinate with Division 25 to provide the DDC connection and an adjustable schedule such that the valve is actuated for 3 minutes (adjustable) once a week.
- .3 Coordinate with Division 26 for solenoid power requirements and location.
- .4 Roof Drain 'RD3': (medium area drain)
 - .1 225mm (9") Commercial spun copper roof drain, 450mm (18") diameter flange.
 - .2 Two-piece membrane clamping system
 - .3 Cast aluminum high-rise dome, vandal resistant fastenings
 - .4 Extension pipe length 300mm (12").

2.9 Safes, Flashing and Vent Terminals

- .1 Metal Flashing: 26 gage galvanized steel.
- .2 Metal Counter flashing: 22 gage galvanized steel.
- .3 Lead Flashing: Waterproofing: 5 lb/sq ft sheet lead.
- .4 Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- .5 Floor Drain Flashing: 40 mil thick chlorinated polyethylene (CPE), equivalent to Chloraloy.
- .6 Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.10 Expansion Tanks – Domestic Hot Water

- .1 Expansion Tank – "ET-1"
 - .1 Diaphragm or bladder type expansion tank, welded steel tank, internal butyl/EPDM diaphragm or butyl bladder, rigid polypropylene liner. Integral floor stand for vertical installation. Listed for potable water systems.
 - .2 ASME rated for a working pressure of 861 kPa (125psi)
 - .3 Amtrol Therm-x-trol model ST-C ___series or equal

2.11 Plumbing Fixtures

- .1 Washer Dryer Station "CW-1"
 - .1 Washer Box: Reversible metal washing machine outlet box, 20 ga, hot and cold ¼ turn supply valves, threaded outlet connections, 2 NPS drain connection, faceplate frame, c/w water hammer arrestors on hot and cold water lines.
 - .1 Oatey #38995 or equal
 - .2 Dryer Box: 22 ga aluminized steel box 525mm x 312mm x 128mm (21"h x 12.5"W x 5" deep), nailing flange, top discharge.
 - .1 Dryerbox model 425 or equal
- .2 Lavatory – Semi-countertop "LAV-1"
 - .1 Design base:
 - .1 Basin: American Standard Mezzo #9960.001

- .2 Trim: Toto Welix EcoPower TEL115-D10E
- .3 Mix Valve: Lawler #TMM1070
- .4 Trap Covering: McQuire ProWrap
- .2 Basin: Semi-counter mount basin, single centre mount hole, nominal dimensions 22" x 21-1/2" x 8-1/4" high, fireclay china, rear overflow, recessed self-draining deck, barrier-free design, and self rimming with sealant.
- .3 Trim: Single handle faucet, polished chrome, single hole installation, 1.2 GPM maximum flow rate, pre-attached flexible supply lines, temperature memory, high-temperature limit stop, ceramic disc valves, less pop-up drain and tailpiece.
- .4 Mixing Valve: Below Deck Mechanical Water Mixing Valve, bronze body, temperature adjusting dial, 10 mm (3/8") inlets and outlet compression fittings, high temperature thermostatic limit stop, shut-off with automatic reset when temperature exceeds 120 °F (48.8 °C), integral checks, offer temperature range from full cold through 46 °C (114.8 °F).
- .5 Provide tee, adaptors, and flexible metal tubing to suit installation.
- .6 Provide tempered water to hot side of faucet.
- .7 Offset Open Grid Drain, cast brass, chrome plated one piece top, 1.5mm (17 GA.) tubular NPS 1-1/4 tailpiece.
- .8 NPS ½ hot and cold commercial duty 1/4 turn ball valve angle stops, chrome finish with escutcheons. Chrome plated flexible metal, low lead riser supplies
- .9 P-Trap, chrome plated, adjustable all metal construction, NPS 1-1/4 size, and escutcheon.
- .10 Prefabricated insulated sanitary covering for trap and supplies, vandal-resistant, flexible seamless moulded closed-cell PVC resin, formulated with anti-microbial additive to limit the growth of fungus and bacteria, to exposed piping (to protect against heat/contusions).
- .3 Lavatory – Wall Hung "LAV-002"
 - .1 Design base:
 - .1 Basin: DXV Cossu #D20125100 / D20126100
 - .2 Trim: Kohler Hint #K-97060-4
 - .3 Wall Carrier: Watts #WCA-411-WC
 - .2 Basin: Rectangle wall-hung lavatory, fine fire clay construction, overflow, single hole, nominal dimensions 20" x 10" x 4-3/4". Colour = white. Refer to drawing plans for handing.
 - .3 Trim: Single handle faucet, polished chrome, single hole installation, 1.2 GPM maximum flow rate, pre-attached flexible supply lines, temperature memory, high-temperature limit stop, ceramic disc valves, less pop-up drain and tailpiece.
 - .4 Open Grid Drain, cast brass, chrome plated one piece top, 1.5mm (17 GA.) tubular NPS 1-1/4 tailpiece.
 - .5 NPS ½ hot and cold commercial duty 1/4 turn ball valve angle stops, chrome finish with escutcheons.
 - .6 P-Trap, chrome plated, adjustable all metal construction, NPS 1-1/4 size, and escutcheon.

- .7 Basin Carrier: Concealed arms, wall flanges to attach to backing plate secured in wall with locking device and levelling screws, heavy gauge steel uprights with integral welded feet. For one unit: 102 mm (4") for two to six units in a row: 152 mm (6") finished metal stud wall to back of pipe space.
- .4 Shower – "SH-1"
 - .1 Design base:
 - .1 Showerhead: Delta #T13H162
 - .2 Floor Drain: JR Smith #2005A
 - .3 Enclosure: Hytec 6101
 - .2 Trim: #R10000-UNWS rough-in, polished chrome plated finish, pressure balance cartridge, temperature only controlled handle, field adjustable to limit handle rotation into hot water zone, shower flow rate max of 1.5 gpm (5.7 l/min)
 - .3 Floor Drain: all duco coated cast iron body, reversible flashing clamp with seepage openings and adjustable 5" diameter nickel bronze 6.35mm thick strainer, secured with ss screws, 102mm throat on strainer
 - .4 Enclosure: Gelcoat finish reinforced with fiberglass, integral foot rests, easy to clean high gloss surface, 2-piece knockdown, 1219mm x 959mm x 2000mm
- .5 Shower – "SH-2"
 - .1 Showerhead: Delta #T13H162
 - .2 Floor Drain: JR Smith #2005A
 - .3 Enclosure: Hytec 3620
 - .2 Trim: #R10000-UNWS rough-in, polished chrome plated finish, pressure balance cartridge, temperature only controlled handle, field adjustable to limit handle rotation into hot water zone, shower flow rate max of 1.5 gpm (5.7 l/min)
 - .3 Floor Drain: all duco coated cast iron body, reversible flashing clamp with seepage openings and adjustable 5" diameter nickel bronze 6.35mm thick strainer, secured with ss screws, 102mm throat on strainer
 - .4 Enclosure: Gelcoat finish reinforced with fiberglass, two convenient toiletry shelves, easy to clean high gloss surface, 2-piece knockdown, 908mm x 933mm x 1988mm
 - .1
- .6 Shower – "SH-3"
 - .1 Showerhead: Delta #T13H162
 - .2 Floor Drain: JR Smith #2005A
 - .3 Enclosure: Hytec S601
 - .2 Trim: #R10000-UNWS rough-in, polished chrome plated finish, pressure balance cartridge, temperature only controlled handle, field adjustable to limit handle rotation into hot water zone, shower flow rate max of 1.5 gpm (5.7 l/min)
 - .3 Floor Drain: all duco coated cast iron body, reversible flashing clamp with seepage openings and adjustable 5" diameter nickel bronze 6.35mm thick strainer, secured with ss screws, 102mm throat on strainer
 - .4 Enclosure: Gelcoat finish reinforced with fiberglass, integral foot rests, easy to clean high gloss surface, 2-piece knockdown, 1524mm x 914mm x 1946mm
- .7

- .8 Sink – Single Compartment “SK-1”
 - .1 Design base:
 - .1 Sink: Franke #LBS4608
 - .2 Trim: Chicago Faucet #430-E28-ABCP
 - .2 Basin: Commercial single bowl countertop mount stainless steel sink, 1 hole, 460 mm (18-1/8") wide x 478 mm (18-13/16") x 203 mm (8") high deep, counter mounted, back ledge, grade 18-10 18 GA. (1.2 mm) type 304 stainless steel, self-rimming, satin finish rim and bowls, mounting kit provided, fully undercoated to reduce condensation and resonance, factory applied rim seal, 89mm (3-1/2") crumb cup waste assembly with NPS 1-1/2 tailpiece.
 - .3 Trim: Single handle Faucet, chrome plated, center hole only, lead free ECAST brass construction, volume control and hot water limit stop cartridge, 3.8 LPM (1.0 GPM) pressure compensating laminar flow (non-aerating) outlet, 241 mm (9-1/2") projection rigid cast brass spout, single metal lever handle.
 - .4 NPS ½ hot and cold commercial duty 1/4 turn ball valve angle stops, chrome finish with escutcheons. Chrome plated flexible metal, low lead riser supplies
 - .5 P-Trap, heavy cast brass adjustable body, with slip nut, NPS 1-1/2 size, box flange, and seamless tubular wall bend.
- .9 Sink – Countertop Integrated “SK-2”
 - .1 Design base:
 - .1 Sink: Basin integral to counter – refer to architectural spec for details.
 - .2 Trim: American Standard Pekoe 4332.350
 - .2 Basin: Basin integral to counter – refer to architectural spec for details.
 - .3 Trim: Forged brass body with brass swivel spout (150° rotation) and swing arm. Metal lever handle. Pull-down spray with adjustable spray pattern and push button activation. Metal reinforced hose with stainless steel protector coil. Washerless 40mm ceramic disc valve cartridge. Brass mounting shank with brass fixation ring. Complete with two integral check valves. Braided flexible supply hoses with 3/8" compression connectors. 2.2 gpm/8.3 Lmin. maximum flow rate.
 - .4 NPS ½ hot and cold commercial duty 1/4 turn ball valve angle stops, chrome finish with escutcheons. Chrome plated flexible metal, low lead riser supplies
 - .5 P-Trap, dishwasher connection where applicable, heavy cast brass adjustable body, with slip nut, NPS 1-1/2 size, box flange, and seamless tubular wall bend.
- .10 Sink – Free Standing Utility “SK-3”
 - .1 Design base:
 - .1 Sink: Global Industrial 670456
 - .2 Trim: American Standard Pekoe 4332.350
 - .2 Basin: One-compartment sink features an 18 gauge stainless steel body with a 8" backsplash and 12" bowl depth. Galvanized steel legs with adjustable impact resistant plastic feet. 1-hole for deck mount faucet. Sink measures 24"W x 24"D x 42"H. NSF Listed.

- .3 Trim: Forged brass body with brass swivel spout (150° rotation) and swing arm. Metal lever handle. Pull-down spray with adjustable spray pattern and push button activation. Metal reinforced hose with stainless steel protector coil. Washerless 40mm ceramic disc valve cartridge. Brass mounting shank with brass fixation ring. Complete with two integral check valves. Braided flexible supply hoses with 3/8" compression connectors. 2.2 gpm/8.3 Lmin. maximum flow rate.
- .4 NPS ½ hot and cold commercial duty 1/4 turn ball valve angle stops, chrome finish with escutcheons. Chrome plated flexible metal, low lead riser supplies
- .5 P-Trap, heavy cast brass adjustable body, with slip nut, NPS 1-1/2 size, box flange, and seamless tubular wall bend.
- .11 Water Closet – Flush Tank “WC-1”
 - .1 Design base:
 - .1 Water closet: American Standard Cadet #2462.100 (4.2L flush)
 - .2 Seat: Centoco #500STSCC
 - .2 Water closet: Pressure-assisted flush tank toilet with elongated bowl. Low consumption toilet, minimum 381 mm high, white vitreous china. Floor mounted, siphon jet flush action, 4.2 L (1.1 US Gal) per flush, two (2) piece assembly, 305 mm (12") rough-in, fully glazed internal trapway, floor outlet, bolt caps. Map test rated to 1000.
 - .3 Seat: Heavy duty, for elongated bowl, open front, white solid plastic, less cover, stainless steel check hinges, metal flat washers stainless steel posts and nuts.
 - .4 NPS ½ cold commercial duty 1/4 turn ball valve angle stop, chrome finish with escutcheons. Chrome plated flexible metal, low lead riser supply
 - .5 Floor Flange, brass or cast-iron floor flange, with all brass bolts and rubber gasket.
- .12 Water Closet – Flush Tank (Barrier Free) “WC-2”
 - .1 Design Base:
 - .1 Water closet: American Standard Cadet Flowise Right Height #2467.601 (4.2L flush)
 - .2 Seat: Centoco #820STS
 - .2 Water closet: Pressure-assisted flush tank toilet with elongated bowl. Barrier free low consumption toilet, minimum 419 mm high, white vitreous china. Floor mounted, siphon jet flush action, 4.2 L (1.1 US Gal) per flush, two (2) piece assembly, bolted tank cover, 305 mm (12") rough-in, fully glazed internal trapway, floor outlet, bolt caps. Map test rated to 1000. Provide trip lever on open side of water closet (wide side)
 - .3 Seat: Heavy duty, for elongated bowl, open front, white solid plastic, with cover, stainless steel check hinges, metal flat washers stainless steel posts and nuts.
 - .4 NPS ½ cold commercial duty 1/4 turn ball valve angle stop, chrome finish with escutcheons. Chrome plated flexible metal, low lead riser supply
 - .5 Floor Flange, brass or cast-iron floor flange, with all brass bolts and rubber gasket.

2.12 Hose Bibs

- .1 Hose Bibb “HB-001”
 - .1 Design base: Zurn F100

- .2 Hose Bibb "HB-002"
 - .1 Design base: Zurn F101

3. EXECUTION

3.1 Piping

- .1 Water pipe connections unless noted otherwise:
 - .1 1½ NPS and less: soldered or screwed joint. For PEX, use cold expansion fittings installed with tools as recommended by the fitting manufacturer.
 - .2 2 NPS: Screwed joint for liquid systems.
 - .3 2½ NPS and larger: Weld or flanged piping including branch connections.
 - .4 Fittings shall be installed according to the manufacturer's instructions.
- .2 Gas pipe connections unless noted otherwise:
 - .1 Inside building - screw or weld 2 NPS and under. Weld 2½ NPS and over.
 - .2 Gas service in ceiling plenums - weld all sizes.
 - .3 Gas service outside building - weld all sizes below ground.
- .3 Use dielectric type couplings when joining dissimilar metal pipes.
- .4 Use lead free solder for soldering domestic water copper pipe.
- .5 Pipe Hangers and Supports
 - .1 Provide hangers and supports to secure equipment in place, prevent vibration, protect against damage from earthquake, maintain grade, provide for expansion and contraction, and accommodate insulation.
 - .2 Natatorium: All hangers and supports shall be hot dipped galvanized and painted in place in the Natatorium.
 - .3 Provide galvanized hangers and supports for all piping except hangers and supports shall be copper plated or epoxy coated for copper piping.
 - .4 Use of perforated straps is not permitted for pipe hangers.
 - .5 Power actuated fasteners and "drop-in" anchors shall not be used.
 - .6 Provide ring type hangers for piping up to NPS 1½ and clevis type hangers for piping over NPS 1½.
- .6 Pressure Testing
 - .1 Advise Consultant or project manager 48 hours minimum prior to performance of pressure tests.
 - .2 Use only potable water for testing of potable water systems.
 - .3 Test pressure shall be the greater of 1.5 times maximum system operating pressure or 860 kPa for 8 hours. For PEX piping, do not exceed 690 kPa (100 psi).
 - .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
 - .5 Conduct tests in presence of construction manager or project manager.
 - .6 Any leaks shall be corrected and the system retested.
 - .7 Insulate or conceal work only after approval and certification of tests by authorities.

- .8 Submit copies of pressure test reports for all sections of piping.

3.2 Pipe Support Spacing

| Material | Maximum Pipe Size NPS | Minimum Rod Diameter mm (in) | Maximum Rod Length mm (in) | Maximum Spacing m (ft) |
|------------------|--------------------------|---------------------------------|-------------------------------|---------------------------|
| Copper And Steel | up to 3/4 | 9 (3/8) | n/a | 1.5 (5) |
| | 1 | 9 (3/8) | n/a | 1.85 (6) |
| | 1 1/4 | 9 (3/8) | n/a | 2.15 (7) |
| | 1 1/2 to 2 | 9 (3/8) | n/a | 2.5 (8) |
| | 2-1/2 to 3 | 12 (1/2) | 635 (25) | 2.75 (9) |
| | 4 to 5 | 16 (5/8) | 785 (31) | 3.7 (12) |
| Steel | 6 | 20 (3/4) | 940 (37) | 5.2 (17) |
| Steel | 8 to 12 | 22 (7/8) | 1090 (43) | 5.8 (19) |

- .1 Plastic or glass pipe
- .1 Refer to manufacturers recommendations for maximum spacing requirements.
 - .2 Utilize the minimum rod diameter and maximum rod length for the corresponding pipe size of steel pipe.
- .2 For rod lengths in excess of the tabulated maximum rod length, reinforcing is required per SMACNA Seismic Restraint Manual or the Seismic Engineers written instruction.
- .3 Expansion Compensation
- .1 Provide structural work and equipment required for expansion and contraction of all piping. Provide anchors, guides, and expansion joints as required to adequately protect the piping systems.
 - .2 Provide expansion compensation for all closed piping systems including but not limited to: heating water, chilled water, steam and condensate, closed condenser water systems, and all other closed piping systems that operate at varying temperatures. Expansion compensation may be eliminated from open systems such as domestic cold, domestic hot, domestic hot recirculating systems except where located in vertical service shafts.
 - .3 All piping shall be anchored and supported in such a manner that strain and/or weight does not come upon any apparatus and pipe branch connections. Expansion joints and compensators shall be installed and guided as per manufacturer's recommendations. All equipment shall be connected with unions or flanges to provide for easy removal. Where piping passes through walls or floor slabs, the sleeves shall be of sufficient size to accommodate the expansion and the pipe insulation, without binding or crushing the insulation or preventing the expansion of the piping.
- .4 Gas Distribution Piping
- .1 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly.
 - .2 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.
 - .3 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
 - .4 Slope piping down in direction of flow to low points.

- .5 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .6 Use dielectric type fittings where buried service enters and connects to building piping.

3.3 Valves

- .1 Install all valves in accordance with manufacturer's recommendations.
- .2 Install valves in accessible locations with stems upright or angled 45° above horizontal unless approved otherwise. Valves must be accessible without removing adjacent piping.
- .3 Install control valves with their stems upright unless approved otherwise and with adequate clearance for removal of actuators.
- .4 Provide stem extensions on all insulated valves.
- .5 Provide full port ball valves in piping 50 mm (2") and smaller and butterfly valves in piping 65 mm (2½") and larger for shut-off, equipment isolation, throttling, bypass or manual flow control services.
- .6 Throttling valves are not to be used for shut-off; additional valves shall be installed for isolation purposes.
- .7 Provide isolation valves at branch take-offs, to isolate each piece of equipment, upstream of all meters, gauges, automatic air vents, and as indicated.
- .8 Use silent check valves on discharge of pumps and in vertical pipes with downward flow, and as indicated.
- .9 Use circuit setting globe valves complete with lockshield to control flow in circuits, except where balancing cocks are specifically specified.
- .10 Install automatic flow limiting balancing valves in domestic hot water recirculation piping.
- .11 Install balancing valves in return piping connections to each terminal heating and cooling unit – e.g. radiators, unit heaters, fan coil units, heating and cooling coils, and radiant panels.

3.4 Piping Insulation Minimum Thickness Schedule

| Type of System | Design Operating Temperature Range °C (°F) | Thermal Conductivity of Insulation | | Nominal Pipe Diameter (NPS) | | | | |
|----------------------|--|------------------------------------|---------------------------------|---|-----------|----------|--------|-----|
| | | Conductivity Range W/m.°C | Mean Rating Temperature °C (°F) | Runouts ≤ 1 | 1 to 1.25 | 1.5 to 3 | 4 to 6 | ≥ 8 |
| | | | | Minimum Thickness of Piping Insulation (mm) | | | | |
| Above Grade Exterior | All | 0.046-0.049 | 121 (250) | 40 | 65 | 65 | 75 | 90 |
| Hot Water Systems | 61-93 (142-200) | 0.036-0.042 | 52 (126) | 40 | 40 | 50 | 50 | 50 |
| | 41-60 (106-141) | 0.035-0.040 | 38 (100) | 25 | 25 | 40 | 40 | 40 |
| Cold Water Systems | 5-13 (41-55) | 0.033-0.039 | 24 (75) | 25 | 25 | 25 | 25 | 25 |
| | <5 (41) | 0.029-0.037 | 10 (50) | 25 | 25 | 25 | 25 | 40 |

Note: Where the thermal conductivity of a proposed insulation is greater than the range specified above, the thickness will be increased by the ratio of U2/U1.

U2 = proposed insulation "k" value at the table mean rating temperature.

U1 = upper range limit "k" value from the table above.

Note: Where thermal conductivity of proposed insulation is less than the range specified above, the thickness may be decreased by the ratio of U2/U1.

U2 = proposed insulation "k" value at the table mean rating temperature.

U1 = lower range limit "k" value from the table above.

- .1 Indoors concealed; factory finish
- .2 Indoors exposed in mechanical room and elsewhere; canvas jacket
- .3 Indoors, exposed in utility areas, parkade, etc.; PVC jacket
- .4 Outdoors; metal jacket

3.5 Safes, Flashing and Vent Terminals

- .1 Provide flexible flashing and metal counter flashing where piping penetrates weather or waterproofed walls and floors.
- .2 CPE, Chloraloy 240 lining or lead material may be used at floor drains and cleanouts. Chloraloy shall be solvent welded to manufacturer's installation instructions. Lead shall not be used on roofs where the roofing material is applied by a torch-on method.
- .3 Flash floor drains in floors with topping over occupied areas with lead or CPE membrane, a minimum of 300mm (12") clear on sides with minimum 900mm x 900mm (36" x 36") sheet size. Fasten flashing to drain clamp device.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Fire stopping of mechanical services penetrating fire separations.
- .2 Related Sections:
 - .1 This section of the Specification forms part of the Contract Documents and shall be read, interpreted and coordinated with all other parts of the Contract Documents including Section 07 84 00 Fire Stopping. If the requirements for fire stopping of mechanical services penetrations of this section differ from the requirements of Section 07 84 00, the most stringent requirements shall apply.

1.2 Intent

- .1 This Section includes through penetration fire stopping and smoke seal systems for penetrations through the following fire resistance rated assemblies, including both empty openings and openings containing penetrating items:
 - .1 Floors
 - .2 Walls and partitions
 - .3 Smoke barriers
 - .4 Construction enclosing compartmentalized areas
- .2 The specification section provides requirements for Rated Systems or systems requiring Engineered Judgements:
 - .1 Use of materials that have not been tested in a system or that are not capable of obtaining an engineered judgement will not be acceptable for use on the Project.
 - .2 Materials having only a ULC label will not be acceptable for use on the Project, unless supporting documentation is provided indicating its use in a listed assembly.

1.3 Scope:

- .1 Provide fire stopping for all mechanical work in Divisions 21, 22, 23 and 25.
- .2 For renovation, projects, in addition to the necessary new penetrations, provide the fire stopping for all existing mechanical assemblies where fire stopping is damaged, discontinued or absent.

1.4 References

- .1 Applicable Building Code - Refer to Section 21 05 01.
- .2 Applicable Fire Code - Refer to Section 21 05 01.
- .3 ASTM E84-18a – Standard Test Method for Surface Burning Characteristics of Building Materials.
- .4 ASTM E119-18a – Standard Test Methods for Fire Tests of Building Construction and Materials.
- .5 ASTM E814-13a (2017) – Standard Test Method for Fire Tests of Penetration Firestop Systems.
- .6 ASTM E1966-15 – Standard Test Method for Fire-Resistive Joint Systems.
- .7 ASTM E 2174 – 18, “Standard Practice for On-Site Inspection of Installed Firestops

- .8 CAN/ULC-S101-14 - Fire Endurance Tests of Building Construction and Materials.
- .9 CAN/ULC-S102-10 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .10 CAN/ULC-S115-11 (R2016) – Standard Method of Fire Tests of Firestop Systems.
- .11 Canada Green Building Council (CaGBC). LEED Canada V4.0- Building Design and Construction, Interior Design + Construction (ID+C).
- .12 Health Canada/ Workplace Hazardous Material Information System (WHMIS).
- .13 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.
- .14 NFPA 101-2012 – Life Safety Code.
- .15 NFPA 251 – Standard Methods of Tests of Fire Resistance of Building Construction and Materials.
- .16 UL 263 – Standard for Fire Tests of Building Construction and Materials (ASTM E119, NFPA 251).
- .17 UL 1709 – Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel.
- .18 UL 1479 – Standard for Fire Tests of Penetration Firestops. (ASTM E814).
- .19 UL 2079 – Standard for Tests for Fire Resistance of Building Joint Systems.
- .20 ULC (Underwriters Laboratories of Canada) - List of Equipment and Materials for:
 - .1 Building Materials.
 - .2 Fire Resistance.
 - .3 Firestop Systems and Components.
- .21 Underwriters Laboratories of Canada (ULC) of Scarborough runs CAN4-S115-M under their designation of ULC-S115-M and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.
- .22 Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their "Products Certified for Canada (cUL) Directory."

1.5 Definitions

- .1 Fire stopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.6 System Description

- .1 Fire stopping systems installed to resist spread of fire and passage of smoke and other gases at penetrations through fire resistance rated wall, floor assemblies, materials, and components.

1.7 Performance Requirements

- .1 Materials, accessories, and application procedures listed by ULC cUL, or tested in accordance with CAN/ULC-S115 to comply with building code requirements.
- .1 Fire stopping Materials: CAN/ULC-S101 ASTM E119 ASTM E814 to achieve a fire rating as noted on Drawings.

- .2 Surface Burning: CAN/ULC-S102 ASTM E84 with a flame spread/smoke developed rating of 25/50.

1.8 Administrative Requirements

- .1 Coordination: Coordinate with other work having a direct bearing on work of this section.
- .2 Pre-installation Meetings: Convene one (1) week before starting work of this section.

1.9 Submittals for Review

- .1 Submit shop drawings for all firestop systems anticipated on this project in accordance with Section 01 33 00 Submittal Procedures.
- .2 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions.
- .3 Shop drawings shall be complete with a systems directory for system details.
- .4 Submit material safety data sheets provided with product delivered to job-site.
- .5 System Design Listings: Submit system design listings, including illustrations from a qualified testing and inspection agency that is applicable for each firestop configuration.

1.10 Quality Assurance

- .1 Products of This Section: Manufactured to ISO 9000 and 14000 certification requirements.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience and FAIC Manufacturer Member in good standing.
- .3 Installer Qualifications:
 - .1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacture's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
 - .2 Installation Responsibility: assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.
 - .3 The work is to be installed by a contractor with at least one of the following qualifications:
 - .1 FM 4991 Approved Contractor
 - .2 UL Approved Contractor
 - .3 Hilti Accredited Fire Stop Specialty Contractor
 - .4 Installer shall have not less than 3 years experience with fire stop installation.
- .4 Retain and pay for the service of a Professional Engineer registered in the Province of British Columbia to inspect each and every mechanical fire stopping installation, and as required by the Authority having jurisdiction, and provide a report on all installations. The fire stopping engineer shall provide letters of assurance to the Owner's Consultant, in accordance with the BC Building Code.

- .5 A manufacturer's direct representative (not distributor or agent) shall be on-site during the initial installation of firestop systems to train appropriate contractor personnel in correct selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- .6 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- .7 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council and the Authorities having jurisdiction and be sealed by a Professional Engineer registered in the Province of British Columbia

1.11 Regulatory Requirements

- .1 Conform to applicable code for fire resistance ratings and surface burning characteristics.
- .2 Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.12 Delivery, Storage and Protection

- .1 Deliver fire stopping products in original, unopened containers with labels intact and legible, identifying product and manufacturer.
- .2 Store and handle fire stopping materials to manufacturer's instructions.

2. PRODUCTS

2.1 Fire Stopping – General

- .1 Use the same product for all like applications.
- .2 Use the same manufacturer throughout the project and compatible materials for restoration work.
- .3 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke, and gases in compliance with requirements of CAN 4-S115-M and not exceeding intended opening sizes.
- .4 Fire stopping components compatible with each other, substrates forming openings and items penetrating the fire stopping under conditions of service and application.
- .5 Provide components for each fire stopping system that are needed to install fill material. Use only components specified by the fire stopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- .6 Where 'cast-in-place' fire stopping materials are used, provide fire stopping devices prior to concrete placement.
- .7 Firestop System Rating:
 - .1 For penetrations through a fire wall or horizontal fire separation provide a firestop system with a 'FT' rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.
 - .2 For combustible pipes, tubing, ducts, chimneys, optical fibre cables, electrical wires and cables, totally enclosed non-combustible raceways, electrical outlet boxes and similar building services that penetrate through a fire separation provide a firestop system with an 'F' Rating as determined by ULC or cUL as indicated below..

| Separation Fire Resistance Rating | Fire Stopping Required ULC or cUL 'F' Rating |
|-----------------------------------|--|
| 30 minutes | 20 minutes |
| 45 minutes | 45 minutes |
| 1 hour | 45 minutes |
| 1.5 hours | 1 hour |
| 2 hours | 1.5 hours |
| 3 hours | 2 hours |

- .3 For joints provide a firestop system with an Assembly Rating as determined by CAN4-S115-M, ULC-S115-M or UL 2079 which is equal to the fire resistance rating of the construction being penetrated.

2.2 Manufacturers

- .1 Subject to compliance with through penetration firestop systems and joint systems listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory, provide products of the following acceptable manufacturers:
 - .1 Refer to Section 23 05 01 Acceptable Manufacturers.
 - .2 Basis of Design: Hilti (Canada) Corporation.
 - .3 JV-Industries Sleeves and Firestop Devices c/w Tremco Firestop materials.

2.3 Accessories

- .1 Fibre Insulation: Alumina-silica refractory fibre insulation in blanket or bulk form with service temperature limit of 1315 degrees C, melting point of more than 1760 degrees C, specific gravity 2.56, thickness to suit application.
- .2 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .3 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .4 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .5 Sealants for vertical joints: non-sagging.

2.4 Materials

- .1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- .2 Pre-Installed firestop devices for use with non-combustible and combustible pipes (closed and open systems) penetrating concrete floors and/or gypsum walls:
 - .1 Hilti Cast-In Place Firestop Device (CP 680-PX or CP 680-P) for use with combustible pipes
 - .1 Add Aerator Adaptor when used in conjunction with aerator system.
 - .2 Hilti Tub Box Kit (CP 681) for use with tub installations.
 - .3 Hilti Cast-In Place Firestop Device (CP 680-M) for use with noncombustible penetrants.

- .4 Hilti Speed Sleeve (CP 653) for use with cable penetrations.
- .5 Hilti Firestop Drop-In Device (CFS-DID) for use with noncombustible and combustible penetrants.
- .6 Hilti Firestop Block (CFS-BL)
- .7 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .3 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit, and electrical metallic tubing (EMT):
 - .1 3M Fire Stop Sealant 2000.
 - .2 3M Fire Barrier CP25 WB.
 - .3 Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - .4 Hilti Fire Foam (CP 620)/CP 660
 - .5 Hilti Flexible Firestop Sealant (CP 606)
 - .6 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 - .7 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
 - .8 Tremco Tremstop Fyre-Sil Sealant.
 - .9 Tremco Fyre-Sil SL.
 - .10 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .4 Sealants or caulking materials for use with sheet metal ducts:
 - .1 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 - .2 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL)
 - .3 Hilti Flexible Firestop Sealant (CP 606)
 - .4 Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - .5 Tremco Fyre-Sil SL Sealant.
 - .6 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .5 Sealants, sprays, or pre-formed materials for use with fire-rated construction joints and other gaps, the following products are acceptable:
 - .1 3M Firestop Sealant 2000.
 - .2 Hilti Top Track Seal (CFS-TTS)
 - .3 Hilti Firestop Top Track Seal for Metal deck (CFS-TTS MD)
 - .4 Hilti Firestop Joint Spray (CFS-SP WB)
 - .5 Hilti Firestop Silicone Joint Spray (CFS-SP SIL)
 - .6 Hilti Flexible Firestop Sealant (CP 606)
 - .7 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 - .8 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL)
 - .9 Hilti Bottom of Wall sealant (CP 605).
 - .10 Tremco TREMstop Acrylic.

- .11 Tremco Dymonic FC.
- .12 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .6 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed flexible cable or cable bundles and plastic pipe:
 - .1 3M Fire Barrier CP25 WB.
 - .2 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
 - .3 Tremco TREMstop IA.
 - .4 Tremco TREMstop WS.
 - .5 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .7 Intumescent sealants, caulking, or putty materials for use with low voltage cabling, communication cabling, and IT cabling:
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - .2 Hilti Fire Foam (CP 620)/660
 - .3 Hilti Flexible Firestop Sealant (CP 606)
 - .4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 - .5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL)
 - .6 Tremco TREMstop IA.
 - .7 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .8 Non-curing, re-penetrable intumescent sealants, caulking, or putty materials for use where future penetrations of low voltage cabling, communication cabling, or IT cabling may occur:
 - .1 Hilti Firestop Putty Stick (CP 618)
 - .2 Hilti Firestop Plug (CFS-PL)
 - .3 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .9 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls, the following products are acceptable
 - .1 Hilti Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.
 - .2 Hilti Firestop Cable Collar (CFS-CC)
 - .3 Hilti Firestop Sleeve (CFS-SL SK)
 - .4 Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.
 - .5 Hilti Gangplate (CFS-SL GP) for use with multiple cable management devices.
 - .6 Hilti Gangplate Cap (CFS-SL GP CAP) for use at blank openings in gangplate for future penetrations.
 - .7 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .10 Wall opening protective materials for use with cUL/ULC listed metallic and specified non-metallic outlet boxes:

- .1 Hilti CP 617 Firestop Putty Pad.
- .2 Hilti Firestop Box Insert
- .3 Tremco TREMstop MP.
- .4 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .11 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems) tested to 50 Pa differential:
 - .1 3M Fire Barrier PPD Plastic Pipe Device.
 - .2 Hilti CP 648E/648S Wrap Strips
 - .3 Hilti CP 643N Firestop Collar.
 - .4 Tremco TREMstop WS.
 - .5 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .12 Materials for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways:
 - .1 3M Firestop Foam 2001.
 - .2 3M Fire Barrier CS-195 Composite Sheet.
 - .3 Hilti Firestop Block (CFS-BL)
 - .4 Hilti Composite Sheet (CFS-COS)
 - .5 Hilti Firestop Mortar (CP 637)
 - .6 Hilti Fire Foam (CP 620)/660
 - .7 Hilti Firestop Board (CP 675T).
 - .8 Tremco TREMstop PS.
 - .9 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .13 Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways:
 - .1 Hilti CFS-BL Firestop Block.
 - .2 Hilti CP 675T Firestop Board.
 - .3 Tremco TREMstop PS.
 - .4 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .14 Sealants or caulking materials used for openings between structurally separate sections of wall and floors:
 - .1 3M Fire Barrier CP 25 WB.
 - .2 Hilti Firestop Joint Spray (CFS-SP WB)
 - .3 Hilti Flexible Firestop Sealant (CP 606)
 - .4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 - .5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL)
 - .6 Tremco TREMstop Fyre-Sil.

- .7 Tremco Dymonic FC.
- .8 Acceptable substitution product listed in the ULC Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory.
- .15 Materials for locations of high re-penetration of low voltage wiring:
 - .1 Hilti Speed Sleeve CP653.
- .16 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected:
 - .1 Hilti CFS-BL Firestop Block (for walls and floors)
 - .2 Hilti CFS-PL Firestop Plug (for walls and floors)
 - .3 Hilti CP 680 Cast-In Place Firestop Device (for floors only)

3. EXECUTION

3.1 General

- .1 The Owner's Consultant shall conduct mandatory destructive reviews for each type of installation. Destructive testing shall be at the discretion of the Owner's Consultant and Authority having jurisdiction
- .2 Allow for destructive testing of 5% of fire stopping applications. Should installations not conform to manufacturer's listed assembly, an additional 25% of installations may be destructively tested and should there be more failures, the contractor will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the project.

3.2 Preparation

- .1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - .1 Verify penetrations are properly sized and in suitable condition for application of materials.
 - .2 Ensure surfaces to which firestop materials will be applied are free of dirt, grease, oil, rust, laitance, release agents, water repellants, and any other substances that may affect proper adhesion.
 - .3 Ensure all service lines are in place, tested and acceptable to the authority having jurisdiction, prior to application of fire stopping and smoke seal.
 - .4 Provide masking and temporary covering to prevent soiling of adjacent surfaces by fire stopping materials.
 - .5 Comply with manufacturer's recommendations for temperature and humidity conditions before, during, and after installation of fire stopping.
 - .6 Do not proceed until satisfactory conditions have been corrected.

3.3 Coordination

- .1 Installation is not to proceed until shop drawings have been reviewed.
- .2 Obtain fire resistance ratings and classifications for all wall and floor assemblies from the Architectural contract documents.
- .3 Coordinate location and proper selection of cast-in-place firestop devices with trade responsible for the work. Ensure device is installed before placement of concrete.

- .4 Provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interference.
- .5 Fire stopping of floor and roof slab penetrations must precede steel stud track installation.
- .6 Fire stopping must precede fireproofing installation.
- .7 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
- .8 Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.
- .9 Fire stopping must precede mechanical pipe insulation. Vapour barriers must be continued along with FPI – ASJ jacketing.

3.4 Installation

- .1 Regulatory Requirements: Install fire stopping and smoke seal material and components in accordance with ULC or cUL Certification and manufacturer's instructions.
- .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.
 - .1 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained by providing an air and water resistant seal.
 - .2 Consult with related trades before installation of ULC or cUL firestop systems that might hamper the performance of fire dampers in ductwork.
 - .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
 - .4 Tool or trowel exposed surfaces to a neat finish.
 - .5 Remove excess compound promptly as work progresses and upon completion.
 - .6 Protect materials from damage on surfaces subjected to traffic.
 - .7 Where possible, use metal sleeves for floor penetrations to prevent/mitigate the consequences of leakage or flooding.

3.5 Field Quality Control

- .1 Notify Consultant when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
- .2 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- .3 Keep areas of work accessible until inspection by applicable code authorities.
- .4 Inspection of through-penetration fire stopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.
- .5 Use primers whenever recommended by manufacturer.
- .6 Perform patching and repairing of fire stopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

- .7 Manufacturer's Field Services: The manufacturer's representative to be present during the first installation of every first firestop system. The manufacturer's technical representative to provide periodic walk-through. After every site visit the manufacturer's technical representative to submit site reports to indicate application reviewed, location and installer. Contractor to submit site reports by manufacturer to consultant within one week of each visit.
- .8 Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
 - .1 The words: "Warning -Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - .2 Contractor's Name, address, and phone number.
 - .3 Through-Penetration firestop system designation of applicable testing and inspecting agency.
 - .4 Date of Installation.
 - .5 Through-Penetration firestop system manufacturer's name.
 - .6 Installer's Name.

3.6 Clean Up

- .1 Remove temporary dams after initial set of fire stopping and smoke seal materials.
- .2 Remove excess materials and debris and clean adjacent surfaces immediately after application.
- .3 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.
- .4 Dispose of waste materials in conformance with Construction Waste Management Plan.

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 This section provides a list of acceptable Manufacturers for this project.

1.2 Related Requirements

.1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Section 21 05 01 – Common Work Results for Mechanical.

1.3 Submittals

.1 Requests for alternate equivalent materials or equipment must be submitted to the Owner's Consultant no later than seven (7) working days prior to the Mechanical trades' closing tender date. Submit all applicable technical data, including performance curves and physical details for review. Approval of requests shall only be given by addendum.

1.4 General Requirements

.1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

.2 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.

.3 The Contractor shall be fully responsible for any additional labour and materials required by any trades or other Contractors to accommodate the use of other than specified materials or equipment. The Contractor shall bear any and all costs for design/system modifications to accommodate the "alternate" equipment. Extras will not be approved to cover such work.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 The following listed Manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed Manufacturers/Suppliers.

.2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.

.3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable Manufacturers and Suppliers list.

.4 Any manufacturers not included on the list of acceptable manufacturers must submit a formal request to be included on this list.

.5 List of acceptable Manufacturers:

| Type of Equipment | Approved Manufacturers |
|---|---|
| Plumbing & HVAC | |
| Access Doors - Drywall | Baucoplus |
| Access Doors - Wall | Maxam, Acudor, Milcor, Can.Aqua, Mifab, Bilco, Baucoplus, Elmdor |
| Actuators | Belimo, Honeywell, Siemens |
| Air Blenders | Blender Products |
| Air Compressor Oil Water Separators | Ingersoll Rand, Sullair, Atlas Copco, Deltech |
| Air Compressors - Dental | Air Techniques, Class 1, Ramvac, Kaeser, Busch |
| Air Compressors - Reciprocating | DV Systems, Ingersoll Rand, Gardiner Denver, Sullair, Kaeser, Atlas Copco, Quincy |
| Air Compressors – Rotary Screw | DV Systems, Ingersoll Rand, Gardiner Denver, Sullair, Kaeser, Atlas Copco, Quincy |
| Air Compressors - Laboratory | Class 1, Amico, Pneumatech, Powerex |
| Air Compressors – For Small In Lab. Installations | Werther International, Jun-Air |
| Air Conditioners - Precision | ClimateWorx, Data Aire Munters, STULZ, Vertiv |
| Air Conditioners – Precision – Rear Door | ColdLogik |
| Air Conditioners - Split System | Daikin, Friedrich, Fujitsu, Mitsubishi, Sanyo, JCI/York |
| Air Curtains | Berner, LJ Wing, Thermoscreens, VTS America |
| Air Dryers - Desiccant | Deltech, Kaeser, Sullair, Ingersoll Rand, Quincy, Deltech |
| Air Dryers - Inline Desiccant | Parker, Eastern Air Products, DV Systems |
| Air Dryers - Refrigerated | DV Systems, Ingersoll Rand, Sullair, Kaeser, Quincy, Gardner Denver, Deltech |
| Air Flow Measuring Air Monitor, Air Stations | Air Monitor, Cambridge, Ebtron, Paragon Controls, Sentinel, |

| Type of Equipment | Approved Manufacturers |
|--|--|
| Plumbing & HVAC | |
| Air Handling Units - Indoor or Outdoor Pre-manufactured | Bousquet, Dunham Bush, Daikin, Engineered Air, Enviro Tec, Haakon, Hunt Air, Pace, Scott Springfield, Ventrol, VTS America |
| Air Handling Units - Large Built-Up | Bousquet, Dunham Bush, Engineered Air, Haakon, Scott Springfield, Hunt Air, Pace, VTS America |
| Air Handling Units - Make-Up Air - Gas-fired | Aaon, Bousquet, Engineered Air, I.C.E., Reznor, Temprite, |
| Air Handling Units - Make-Up Air – Hydronic and Electric | Aaon, Addison, Daikin, Systemair |
| Air Handling Units - Packaged | Carrier, Daikin, Dunham Bush, Engineered Air, Lennox, Trane, VTS America, York (Johnson Controls) |
| Air Separators | Armstrong, Bell & Gossett, Spirotherm, Taco, Wessels, Wheatley, Caleffi, Nexus |
| Air Terminals - Fixed Louvre | Airolite, CS Louvre (Exhaust Use Only), EH Price, Nailor, Ten Plus Architectural Products Ltd., Ruskin, Ventex, Westvent |
| Air Terminals - Grilles, Registers, Diffusers | Anemostat, E.H. Price, Krueger, Nailor Industries, Tuttle & Bailey, Swegon, Titus, Trox, |
| Air Terminals – Hospital OR | SLD Technology |
| Air Terminals - Motorized Louvre | Airolite, Pottorff, Ruskin |
| Air Terminals - Supply Air HEPA Terminal | EH Price, Krueger, Swegon, Titus, Tuttle & Bailey |
| Air Terminals - Wall Cap | |
| Balancing Agents (BC) | KD Engineering, MDT Systems, Western Mechanical Systems, Blue Collar Group, Flotech Mechanical, Raincity Technical Services, NovaGreen |
| Chimneys, Breeching and Venting | DuraVent, ICC, Metal Fab, Selkirk |
| Cleaning Agencies - Ductwork | Power Suction Services, Enviro-Vac Systems Inc., Clean Air Services Canada |
| Clothes Dryer Box | Dryerbox |
| Clothes Dryer Lint Trap | Fantech, Ortech, Reversomatic |

| Type of Equipment | Approved Manufacturers |
|---|--|
| Plumbing & HVAC | |
| Clothes Washer Shut Off Valve / Drain Box | Oatey, Watts, Zurn, Sioux Chief |
| Coil Hookups Manual Balancing | Tour and Anderson Koil-Kit |
| Coils - Heating and Cooling | Trane, Aerofin, Engineered Air, Colmac, Rosemex, Temtrol, Armstrong, Cooney Coils, CoilMaster, madok |
| Commissioning Agents | AME Group, KD Engineering, Blue Collar Group, MDT Systems, Western Mechanical Services, Kane Consulting, Wyndham Commissioning (Vancouver Island), WSP, Zenith, Raincity Technical Services |
| Compressed Air – Aluminum Pipe | Transair, Champion, Topring, AirNet |
| Compressed Air – Filters, Regulators, Lubricators | Ingersoll Rand (ARO), Topring, Lincoln, Amflo |
| Compressed Air Hose Reels | Raasm, Reelcraft, Graco, Lincoln, Samson, Topring |
| Compressed Air Receiver Tanks | Highland Tank, Ingersoll Rand, Kaeser |
| Compressed Air Solenoid Valves | ASCO, Apollo, Omega |
| Condenser Units – Air Cooled | Arctic Chillers, Carrier, Daikin, Dunham Bush, Trane, |
| Condensing Units - Refrigerant | Arctic Chillers Carrier, Daikin, Dunham Bush, Johnson Controls, Keeprite, Trane, |
| Controls Contractors - Victoria | Cougar Pacific (Alerton, Honeywell Building Solution), Foster Air Conditioning (Reliable), Houle (Reliable), Island Temperature Controls (Delta), Kerr Controls (Reliable), SRD Controls Inc. (Reliable) |
| Controls – Room Pressure | Critical Room Control, Paragon Controls, Triatek/JCI, TSI |
| Dampers - Backdraft | Alumavent, E.H. Price, Penn, Pottorff, Ruskin, Tamco |
| Dampers – Backdraft – Heavy Duty | Pottorff, Ruskin CBS7, Tamco |
| Dampers - Balancing | Maxam, Ruskin |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Dampers - Control | EH Price, Nailor Industries, Pottorff, Ruskin, Tamco |
| Dampers - Fire | Alumavent, EH Price, Maxam, Nailor Industries, Pottorff, Ruskin |
| Dampers - Fire / Smoke Combination | EH Price, Maxam, Nailor Industries, Pottorff, Ruskin |
| Dampers - Motorized | Alumavent, EH Price, Maxam, Nailor Industries, Pottorff, Ruskin, Swegon, Tamco |
| Drinking Fountains - Non-Refrigerated | Haws, Elkay, Sunroc, Aquarius, Halsey-Taylor |
| Drinking Fountains - Refrigerated | Haws, Cordley, Elkay, Halsey-Taylor |
| Ductwork - Access Doors | Nailor Industries, Ortech, Ventlok |
| Ductwork - Concealed Regulator | Maxam, Pottorff, Ruskin, Young |
| Ductwork - Duct Connectors - Thermal Break | Ventifabrics "Ventlon" |
| Ductwork - Duct Connectors - Vibration | Duro Dyne "Durolon", Dynair "Hypalon", Ventfabrics "Ventlon" |
| Ductwork - Duct Sealer | Foster 32-14, Hardcast Versa Grip, Hardcast Foil Grip 1402, United Duct Sealer, Trans Continental Multi-Purpose |
| Emergency Equipment (Eye Wash, Showers) | Haws, Guardian, Bradley, Acorn Speakman |
| Emergency Equipment – Thermostatic Mixing Valves | Guardian, Haws, Bradley Acorn, Speakman |
| Expansion Fittings - Flexible Hoses | Anvilstar, Griswold Controls, Metraflex, Nexus Valve, Tri-Flex Loop, Unisource Mfg. |
| Expansion Fittings - Joints - Bellows Type | Adsco, Anaconda, Flexonics, Hydro-Flex, Tube Turns, United Flexible, Vibra-Flo |
| Expansion Fittings - Joints - Grooved Type | Victaulic, Gruvlok |
| Expansion Fittings - Joints - Sleeve Type | Badger, Flexonics, Tube Turn, Yarway |

| Type of Equipment | Approved Manufacturers |
|--------------------------------------|---|
| Plumbing & HVAC | |
| Fan Coil Units | Carrier, Daikin, Dunham Bush, Engineered Air, Enviro Tec, First Co., Johnson Controls, PolarAir, Trane, Williams, Polar Air, Kampmann, MDL Verano |
| Fans – Axial - Tube | Canadian Blower, Chicago Blower, Greenheck, Loren Cook, New York Blower, PennBarry, Sheldons, Twin City |
| Fans – Axial - Vane | Canadian Blower, Chicago Blower, Greenheck, Loren Cook, New York Blower, PennBarry, Sheldons, Twin City |
| Fans - Bathroom Ceiling Fan | Acme, Delta Breez, Broan, Greenheck, Loren Cook, Ortech, Panasonic, Pennbarry, Reversomatic, S&P, Twin City |
| Fans - Bathroom Exhaust | Acme, Delta Breez, Broan, Greenheck, Loren Cook, Ortech, Panasonic, Pennbarry, Reversomatic, S&P., Twin City |
| Fans - Cabinet - General Purpose | Greenheck, PennBarry, Loren Cook, Delhi, Twin City |
| Fans - Centrifugal | Acme, Chicago Blower, Greenheck, Loren Cook, New York Blower, PennBarry, S&P, Sheldons, Twin City |
| Fans - Dryer Exhaust Booster Fan | Fantech, Ortech, Reversomatic |
| Fans – HVLS | Big Ass Fan, Envira-North |
| Fans - In-Line Centrifugal | Chicago Blower, Delhi, Greenheck, PennBarry, Loren Cook, S&P, Twin City |
| Fans - In-Line Centrifugal (Tubular) | Chicago Blower, Greenheck, Loren Cook, New York Blower, PennBarry, S&P, Twin City |
| Fans – Mixed Flow Induced Dilution | Greenheck, Loren Cook, Strobic, Twin City, skyplume |
| Fans - Parkade Transfer | Systemair, Zoo Fans |
| Fans - Propeller | ACME, Greenheck, Loren Cook, New York Blower, PennBarry, S&P, Twin City |
| Fans - Range Hoods | Broan, Nutone, Ortech, Reversomatic, Viking |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Fans - Roof and Wall Mounted | ACME, Greenheck, Loren Cook, New York Blower, PennBarry, S&P, Twin City |
| Fans - Utility | Greenheck, Loren Cook, New York Blower, PennBarry, Reversomatic, S&P, Sheldons, Twin City |
| Fans - Vent Sets | Canadian Blower, Greenheck, Loren Cook, New York Blower, PennBarry, Sheldons, Twin City |
| Faucets | Acorn, Alsons, American Standard, Bradley, Cambridge, Chicago, Delta, Grohe, Kohler, Moen, Sloan, Symmons, TOTO, T&S Brass |
| Filters - Air - Housings | AAF Poly-Seal, Cambridge Side-Flo, Camfil Glide/Pack |
| Filters - Air - Mechanical | AAF, Cambridge, Camfil, Flanders, Pacific, Viledon |
| Filters - Domestic Water - Cartridge | US Filter, Steri-flo |
| Filters – Domestic Water - Self Cleaning | Orival, Judo, Forstra Filters |
| Firestopping | Hilti (Canada) Limited, 3M Fire Protection Products, Tremco Sealants & Coatings, AD Firebarrier, Specified Technologies Inc (STI) |
| Flexible Connectors - Ducting | Thermaflex, G.I. Industries Type IHP |
| Flexible Connectors - Piping | Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason, Techniquip, United Flexible, Triflex, Victaulic, Anvilstar, Unisource |
| Flexible Ductwork | Flexaust, Flexmaster, Thermaflex, Wiremold, GI Industries |
| Flow Meters - Compressed Air Meter | Onicon |
| Flow Meters - Electromagnetic Meter | Onicon, Armstrong Veris |
| Flow Meters - Inline Electromagnetic Meter | Onicon, Armstrong Veris |
| Flow Meters - Orifice Plate | Gerand, Armstrong Veris |
| Flow Meters - Pitot Tube | Presco, Anubar |

| Type of Equipment | Approved Manufacturers |
|---|--|
| Plumbing & HVAC | |
| Flow Meters - Sat steam Meter | Onicon, Armstrong Veris |
| Flow Meters - Turbine Flow Meter | Onicon, Armstrong Veris |
| Flow Meters - Ultrasonic Meter | Onicon, Armstrong Veris |
| Flow Meters - Venturi | Gerand, Presco, Armstong Veris |
| Flow Meters - Vortex Meter | Onicon, Armstrong Veris |
| Gas Monitoring Systems (CO, CO2, NO2, etc.) | ACME, Critical Environment Technologies, Honeywell, MSA, QEL, Opera/Belimo, Canadian Gas Service |
| Gauges - Air | Dwyer, Magnehelic |
| Gauges - Differential Pressure | Dwyer |
| Gauges - OWG Pressure | Trerice, Marsh, Ashcroft, Weiss, Moeller, Miljoco, Weksler, Winders |
| Geotextile Filter Fabric for Footing Drains | Mirafi, Permaliner, Terrafix, Nilex |
| Grooved Mechanical Pipe Couplings / Valves / Fittings | Victaulic, Shurjoint, Gruvlok |
| Heat Recovery Ventilators (HRV) | Aldes, Bousquet, Building Performance Equipment, Engineered Air, Greenheck, JCI, Lossnay, NU-air, RenewAire, Reversomatic, Swegon, Tempeff, VanEE, Venmar, Ventus, Oxygen 8, Aurua Green, System Air |
| Heaters - Electric – Baseboard | Chromalox, Ouellet |
| Heaters - Electric - Cabinet | Ouellet, Q-Mark |
| Heaters - Electric - Convactor | Chromalox, Ouellet, Q-Mark |
| Heaters - Electric - Duct | Chromalox, Neptronic, Thermolec |
| Heaters - Electric - Radiant Panel | Q-Mark |
| Heaters - Electric - Unit Heaters | Chromalox, Q-Mark |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Heat Tracing | nVent/Rachem, Serge Baril |
| Hoods – Intake/Exhaust | Acme, Alumavent, Greenheck, Penn Barry, S&P, Twin City Fan |
| Hoods – Kitchen Range | Broan, Jenn Air, Ortech, Reversomatic, S&P |
| Hose Reels (For shop area engine oils, transmission fluid, etc.) | Graco, Samson, Lincoln, Raasm, Topring, Reelcraft |
| Insulation - Acoustic - Duct - Fibre-Free | K-flex, Armacell, Evonik (Solcoustic) |
| Insulation - Acoustic - Duct | Manson, Knauf, CertainTeed, Johns Manville, Owens Corning, Evonik |
| Insulation - Canvas jacket | Robson, Fattal, Tai-Can |
| Insulation - Fabric Adhesive, Coatings | Robson, Bakor, Childers, Epolux, Foster |
| Insulation - High Temp Pipe Insulation - Calsil | Johns Manville – IIG |
| Insulation - Low Temp Preformed Pipe Insulation | Aeroflex, Armacell, Therma-Cel, Kingspan |
| Insulation - Low to Intermediate Temp Pipe Insulation | Knauf, Owens Corning, Roxul, Johns Manville, Manson |
| Insulation - PVC jacket | Knauf, Speedline, Proto, Zeston, Shur-Fit, Belform |
| Insulation - Thermal - Duct | CertainTeed, Manson, Knauf, Johns Manville, Owens Corning |
| Insulation - Thermal - Pipe | Manson, Knauf, Johns Manville, Owens Corning |
| Insulation - Undersink Piping Covers | McGuire, Truebro, Brocar |
| Insulation - Vapour Barrier Jacket Adhesive | Bakor, Epolux, Nacan, Foster, Childers |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Insulation – Vapour Barrier-Jacket | Knauf ASJ, Kingspan ASJ, Manson ASJ, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ, VentureWrap 1555U. |
| Interceptor - Grease | Zurn, Watts, Mifab, Jay.R. Smith |
| Interceptor - Oil | Zurn, Watts, Mifab, Jay R. Smith |
| Meters - HVAC / Plumbing | Marsh, Weiss, Marshalltown, Taylor, Terice |
| Meters - Water - Positive Displacement | Neptune, Rockwell |
| Pipe and Valve Identification | Seton, Brady, Incom |
| Pipe Restraints | Trelleborg |
| Piping - Ductile Iron Grooved Pipe | Canada Pipe |
| Piping - Insulation Shields | Klo-Shure |
| Piping – No-Hub Cast Iron-Fitting Restraints | HoldRite |
| Piping - Potable Water Copper Roll Grooved Pipe | Victaulic copper connection, Grinnell Gruvlok, Shurjoint |
| Piping - Potable Water Type K Copper Press Type Joining Method for LMFV Facilities | For 12mm up to 50mm dia. only: Viega ProPress, Grinnell G-Press, Streamline (Mueller Industries) |
| Piping - PVC Perforated for Footing Drains | Ipex, Napco |
| Piping - Sanitary / Storm - PVC 15 (XFR) pipe | Ipex |
| Piping - Sewage - Chlorinated Polyvinyl Chloride (DWV) | Ipex, Napco |
| Piping - Sewage - Glass DWV | Kimax |
| Piping - Sewage - Poly Propylene | Ipex, Orion |
| Piping - Sewage - Polyvinylidene Fluoride DWV | Ipex, Orion |
| Piping – PVC DWV – Double Wall Containment | Ipex |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Piping - Steam and Condensate - Pre-Insulated Direct Buried Pipe | Perma-Pipe, Logster, Urecon |
| Piping Hangers and Saddles | Anvil, Myatt |
| Plumbing - Air Admittance Valves | Studor, Oatey, FraJon, Sioux Chief |
| Plumbing - Air Vents | Watts, Bell & Gossett, Caleffi, Braukmann, Armstrong, Maid-O-Mist, Hoffman, Taco |
| Plumbing - Backflow Preventers | Watts, Hersey, Singer, Ames, Wilkins, Conbraco, Febco |
| Plumbing - Cleanouts | Watts, Jay R. Smith, Zurn, Mifab |
| Plumbing - Dielectric Unions | Watts, Zurn, Mifab |
| Plumbing - Floor Drains | Jay R. Smith, Watts, Zurn, Mifab |
| Plumbing - Hose Bibbs / Wall Hydrants | Jay R. Smith, Watts, Zurn, Enpoco, Jenkins, Dahl, Toyo, Kitz, Mifab, Woodford, Acorn, Crane |
| Plumbing - Interceptors (Plastic) | Greenturtle, Canplas, SMS |
| Plumbing - Plug Cocks | DeZurik, Newman-Milliken |
| Plumbing - Roof Drains | Jay R. Smith, Watts, Zurn, Mifab |
| Plumbing - Solids Interceptors | Watts, Zurn, Mifab, Jay R. Smith |
| Plumbing - Spun Copper / Aluminum Roof Drains | Menzies, Enpoco, Precision Metal |
| Plumbing - Trap Primers | Watts, Zurn, Precision Plumbing Products, Jay R. Smith |
| Plumbing - Trap Primers Electronic | Precision Plumbing Products, Mifab, Zurn, Sioux Chief |
| Plumbing – Trap Seals | MiFab, Zurn, Green Drain |
| Plumbing - Trench Drains | Jay R. Smith, Watts, Zurn, NDS, MEA, ACO |
| Plumbing - Vacuum Breakers | Watts, Febco, Conbraco |
| Plumbing - Water Hammer Arrestors | Sioux Chief, Zurn, Watts |
| Plumbing Fixtures - Carriers | Zurn, Watts, Jay R. Smith, Mifab |

| Type of Equipment | Approved Manufacturers |
|---|---|
| Plumbing & HVAC | |
| Plumbing Fixtures - Faucets | Crane, American Standard, Kohler, Moen, Sloan, Symmons, Toto, Zurn, Delta, Chicago Faucets, Mansfield, Elijer |
| Plumbing Fixtures - Flush Valves | Sloan, Zurn, Crane, Chicago, Delta, Moen |
| Plumbing Fixtures - Prefab FRP | Aquarius, Acrylic Tubs |
| Plumbing Fixtures - Showers - Fixtures | Symmons, Acorn, Bradley |
| Plumbing Fixtures - Showers - Institutional | Symmons, American Standard, Acorn |
| Plumbing Fixtures - Showers - Stalls | Hytec, Maax, Mirolin |
| Plumbing Fixtures - Sinks - Mop | Fiat, Crane, American Standard, Mustee |
| Plumbing Fixtures - Sinks - Stainless Steel | Franke/Kindred, American Standard, Elkay, Novanni |
| Plumbing Fixtures – Shampoo Basins | Belvedere, Willoughby Industries |
| Plumbing Fixtures – Pressure Balance Mixing Valves | Symmons, Leonard Acorn Powers |
| Plumbing Fixtures - Thermostatic Mixing Valves | Symmons, Bradley, Powers, Lawler, Leonard, Watts, Zurn, Crane, Armstrong |
| Plumbing Fixtures - Wash Fountains, Multi-station Washsinks | Bradley, Acorn, Willoughby Industries |
| Plumbing Fixtures - Water Closets | TOTO, American Standard, Kohler |
| Plumbing Fixtures – Water Closet in-Wall Flush Tanks | TOTO, Kohler, Geberit, Swiss Madison |
| Plumbing Fixtures - Water Closets - Seats | Centoco, Bemis, Olsonite, Moldex, Beneke |
| Pre-Cast Manholes, Sumps and Catch Basins | Langley Concrete, Ocean Pipe, Precon, Lafarge Canada |
| Pump Accessories - Suction Diffusers | B&G, Armstrong, Grundfos, Taco, Victaulic, Wilo |
| Pump Accessories - Triple Duty Valves | Armstrong, B&G, Victaulic, Taco, Wilo |

| Type of Equipment | Approved Manufacturers |
|--------------------------------------|--|
| Plumbing & HVAC | |
| Pumps - Air Operated Diaphragm | Raasm, Graco, Aro (Ingersoll Rand), Lincoln, Samson |
| Pumps - Base Mounted | Armstrong, Aurora, Bell & Gossett, Grundfos, Taco, Wilo |
| Pumps – Boiler Feed | Sihi |
| Pumps - Centrifugal | Armstrong, Bell & Gossett, Grundfos, Taco, Wilo |
| Pumps - Condensate | Little Giant, Ecoflo, DiversiTech |
| Pumps - Condensate Packages | Bell & Gossett, Paco, Plad, Skidmore, Spirax Sarco |
| Pumps - Deaerators and Boiler Feed | York Shipley, Cleaver Brooks, Duro |
| Pumps - Domestic Water Booster | Armstrong, Bell & Gossett, Grundfos, Plad, Quantum Flo |
| Pumps – Well Pump for Domestic Water | Little Giant, Grundfos, Goulds/Xylem |
| Pumps – Fuel Oil | Roto King, Viking, Worthington |
| Pumps - In-Line Circulators | Armstrong, Bell & Gossett, Grundfos, Taco, Wilo |
| Pumps - Manual / Hand | Crane |
| Pumps - Peristaltic | Canamix |
| Pumps - Positive Displacement | Viking, Fairbanks, Morse, Ebara |
| Pumps - Submersible Bilge or Sewage | Monarch, Barnes, Hydromatic, Myers, Zoeller |
| Pumps - Sump | Bell & Gossett, Monarch, Barnes, Hydromatic, Myers, Zoeller, Plad, Liberty |
| Pumps - Turbine | Aurora |
| Pumps - Vertical In-Line | Armstrong, Bell & Gossett, Grundfos, Taco, Wilo |
| Reverse Osmosis U.V. Sterilizers | Trojan, Triogen, Hanovia, ETS |
| Silencers - Fan and Duct | E. H. Price, Kinetics Noise Control, Vibro Acoustics, VAW Systems |
| Strainers - Basket (Pool) | Nemato / Mermaid |

| Type of Equipment | Approved Manufacturers |
|-------------------------------------|--|
| Plumbing & HVAC | |
| Strainers - HVAC / Plumbing | Kitz, Red & White/Toyo, Mueller Loxend, Sarco, Armstrong, Victaulic, Anderson, Yarway |
| Tanks - Domestic Hot Water Storage | Aerco, AO Smith, Bradford White, Clemmer, Everdur, Lochinvar, Niles, PVI, Ruud/Rheem, State, Viessmann |
| Tanks - Expansion | Amtrol, Armstrong, Bell & Gossett, Sparco Taco, Watts, Wessels, Wheatley, State |
| Test Plugs – Pressure / Temperature | Flow Design Superseal, Miljoco P/T Plugs, Sisco P/T Plugs |
| Thermometers | Terice, Marsh, Ashcroft, Winters, Moeller, Weiss, Weksler, Winters |
| Unit Ventilators | Maxair, ChangeAir |
| Valves - Alarm | Fire Flex, Reliable Simplex Grinnell, Tyco, Victaulic, Viking |
| Valves - Auto Balance | Griswold, Hays, Nexus Valve, Tour and Anderson |
| Valves – Backwater | Zurn, J R Smith, Watts, Wade |
| Valves – Ball | Apollo, Crane/Jenkins, KVC, Gruvlok, Kitz, NCI Canada, Nexus Valve, Red&White, Victaulic, Watts |
| Valves – Butterfly | Apollo, Bray, Centreline, Crane, DeZurik, Dresser, Grinnell, Jenkins, Keystone, Kitz, KVC, Loxend, Lunkenheimer, Monotight, Mueller, NCI Canada, Nexus Valve, Red & White, Toyo, Victaulic, Watts |
| Valves – Check – Lever and Weight | Cla-Val, Valmatic, Mueller, Kennedy |
| Valves – Check – Silent | APCO, Gruvlok, NCI Canada, StreamFlo, Val-matic, Victaulic |
| Valves – Check – Spring Loaded | Victaulic, Mueller Loxend, Moygro |
| Valves – Check - Swing | Bonney Forge, Crane, Hattersley, Kitz, NCI Canada, Nibco, Red-White/Toyo |
| Valves – Circuit Balancing | Armstrong, Bell & Gossett, Griswold, Tour and Andersson, Nexus Valve, Preso, Wheatley |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Valves - Control - Pressure Independent | Belimo, Flow Control Industries, Griswold, Tour & Andersson, Victaulic |
| Valves – Domestic Water Automatic Balancing. | Circuit Solver |
| Valves – Domestic Water Balancing | Armstrong, Bell & Gossett, Griswold, Nexus Valve, Red & White/Toyo |
| Valves – Drain - Radiator | Crane, Dahl, Jenkins, Kitz, Nexus Valve, Toyo |
| Valves – Eccentric Plug | DeZurik, Homestead |
| Valves – Gate | Bonney Forge, Crane, Hattersley, Kitz, NCI Canada, Nibco, Red-White/Toyo |
| Valves – Globe | Bonney Forge, Crane, Hattersley, Kitz, NCI Canada, Nibco, Red-White/Toyo |
| Valves – Memory Radiator Balance | Dahl |
| Valves – Pool | Chemline, Hayward, Braukmann |
| Valves - Pressure Balance Mixing Valves | Symmons, Leonard, Acorn, Powers |
| Valves – Pressure Reducing | Watts, Armstrong, Bell & Gossett, Taco, Crosby, Sarco, Clayton, Singer, Zurn, Wilkins, BCA, Cash Acme, Braukman, Bermad/Victaulic |
| Valves - Pressure Sustaining | Cla-Val, Singer |
| Valves – Radiators | Dahl, Crane, Red & White/Toyo, Kitz |
| Valves – Relief | Armstrong, Bell & Gossett, Taco, Wheatley, Watts, Farris, Singer, Lonergan |
| Valves – Relief – Water Bypass | Braukmann, Fulflo, Lonergan |
| Valves – Seismic | Koso, Pacific Seismic Products |
| Valves – Thermostatic Mixing | Cash Acme, Symmons, Leonard, Powers |
| Valves – Thermostatic Mixing for Emergency Safety Equipment. | Guardian, Haws, Bradley, Speakman |
| Variable Frequency / Speed Drives | ABB, Allen-Bradley, Baldor, Danfoss, Eaton, Hitachi, Siemens, Teco-Westinghouse, Toshiba, WEG, Yaskawa |

| Type of Equipment | Approved Manufacturers |
|--|---|
| Plumbing & HVAC | |
| Vibration – Neoprene Pad | Mason, Korfund, Vibro-Acoustics |
| Vibration – Neoprene Washer Bushing | Mason, Korfund, Vibro-Acoustics |
| Vibration – Post Disaster Seismic Snubbers | Mason, Korfund, Vibro-Acoustics |
| Vibration – Restrained Air Springs | Mason, Korfund, Vibro-Acoustics |
| Vibration – Rubber Floor Mounts | Mason, Korfund, Vibro-Acoustics |
| Vibration – Seismic Snubbers | Mason, Korfund, Vibro-Acoustics |
| Vibration – Spring Floor Mounts | Mason, Korfund, Vibro-Acoustics |
| Vibration – Spring Hangers | Mason, Korfund, Vibro-Acoustics |
| Vibration Isolation | Mason, Korfund, Vibro-Acoustics |
| VRF/VRV HVAC System | Daikin, Hitachi, Johnson Controls, LG, Mitsubishi, Samsung, Trane |
| Water Heater - Electric – Storage Tank/Heater (Commercial) | AO Smith, Rheem, Bradford White |
| Water Softeners | Duro, Petwa, Gladwell, Water Conditioning Canada |
| Water Treatment Agents | Pace Chemicals, Dubois Chemicals, Enercon, specified/magnus |

| Type of Equipment | Approved Manufacturers | Notes |
|---------------------------------|--|---|
| Fire Suppression Systems | | |
| Air Compressors | Swan, General Air, Gast, C-Aire | |
| Backflow Preventers | Watts, Ames, Wilkins | Backflow preventers used in fire suppression systems must be listed for fire suppression use. |
| Fire Department Connections | National Fire Equipment, Wilson & Cousins, Elkhart | |
| Fire Extinguishers and Cabinets | National Fire Equipment, Wilson & Cousins, Guardian, Ansul | |
| Fire Hose Cabinets | National Fire Equipment, Wilson & Cousins, Guardian | |

| Type of Equipment | Approved Manufacturers | Notes |
|---------------------------------------|---|---|
| Fire Suppression Systems | | |
| Sprinkler Zone Cabinets | National Fire Equipment, PotterRoemer | |
| Flow Switch Test Assembly | Victaulic, Tyco, Viking | |
| Flow Switches | Potter, System Sensor | |
| Pressure Switches | Potter, System Sensor | |
| Supervisory Switches | Potter, System Sensor | |
| Fire Pumps | Armstrong, Aurora, A-C Fire Pumps, Peerless | |
| Jockey Pumps | Armstrong, Aurora, A-C Fire Pumps, Peerless | |
| Fire Pumps / Jockey Pumps Controllers | Tornatech, Cutler Hammer, Firetrol | |
| Flow Meters | Victaulic, Tyco, Guardian | |
| Fire Pump Diesel Engine | Clarke, Cummins, Caterpillar | |
| Fire Pump Electric Motors | Baldor, General Electric, U.S. Motors | Electric motors shall be listed for fire service. |
| Heat Tracing | nVent/Raychem | |
| Sprinkler Heads | Viking, Tyco, Reliable, Victaulic | |
| Valves - O.S.& Y. | Tyco, Victaulic, Nibco | |
| Valves - Butterfly | Tyco, Victaulic, Nibco | |
| Valves - Check | Tyco, Victaulic, Nibco | |
| Valves - Dry Pipe | Tyco, Viking, Reliable, Victaulic (Victaulic valve manufactured prior to December 2010 shall not be used.) | |
| Valves - Pre-Action | Tyco, Viking, Reliable, Victaulic (Victaulic valve manufactured prior to December 2010 shall not be used.) | |
| Valves - Deluge | Tyco, Viking, Reliable, Victaulic (Victaulic valve manufactured prior to December 2010 shall not be used.) | |
| Reels and Racks | National Fire Equipment, Guardian, Wilson & Cousins | |
| Pre-Action Cabinet Systems | Viking, Tyco, Victaulic | |
| Pre-Action Release Panels | Viking, Simplex, Mircom | Panel must be compatible with |

| Type of Equipment | Approved Manufacturers | Notes |
|---|---|---|
| Fire Suppression Systems | | |
| | | building fire alarm panel |
| Seismic Flexible Hose Connections | Metraflex, Anvil, Flex-Hose | |
| Spare Sprinklers Cabinet | Tyco, Viking, Victaulic | |
| Braided Flexible Sprinkler Connectors | Tyco, Viking, Reliable, Victaulic | |
| Diesel Engine Fuel Oil Tank | Regal, AGI/Westel, Steelcraft | |
| Diesel Fuel Oil Tank Overfill Protection Device | OPW, Franklin, Morrison Bros | |
| Diesel Fuel Oil Tank Remote Fill Box | OPW, Franklin, Morrison Bros | |
| Clean Agent Fire Extinguishing Systems | Inergen, Novec 1230, FM 200 | Halon systems shall not be used. (Halon use phased out in 2010) |
| Nitrogen Generators | General Air Products, South-Tek Systems, Engineered Corrosion Solutions (ECS) | |

3. EXECUTION

3.1 Post Tender Submission Requirement

.1 Submit within 14 days of contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the tender. If no Manufacturer's names are submitted, it will be assumed that the price carried in the tender was that of the specified Manufacturer or where the specified product is generic, the first acceptable Manufacturer listed for each item and equipment.

END OF SECTION

1. GENERAL

1.1 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 General Scope

- .1 'Provide' shall mean 'supply and install'.
- .2 'Consultant' shall mean AME Group Consulting Professional Engineers
- .3 Provide complete, fully tested, and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.
- .4 Contract documents and drawings of this Division are diagrammatic and approximately, to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.
- .5 Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.
- .6 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of tender.
- .7 Clarifications or requests for alternate materials or equipment must be submitted in writing to the Consultant no later than seven (7) working days prior to the Mechanical trades' closing tender date. Approval of requests shall only be given by addendum.
- .8 Make reference to electrical, mechanical, structural, and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.

1.3 Code Compliance, Permits and Fees

- .1 All work shall comply with current editions of the National, Provincial and Municipal Codes, Standards, Acts and Bylaws and will meet the requirements of the Authority having jurisdiction.
- .2 Obtain all permits and pay all fees applicable to the scope of work. Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.4 Tender Price Breakdown

- .1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format agreed to with the Consultant. As a minimum, include the following in the tender price breakdown:
 - .1 Mechanical: Equipment, materials, labour
 - .2 Plumbing: Equipment, materials, labour
 - .3 Sheet Metal: Equipment, materials, labour
 - .4 Fire protection: Equipment, materials, labour
 - .5 Controls: Equipment, materials, labour

1.5 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures and in addition the following:
- .2 Contractor shall provide and submit to the Consultant Assurance of Professional Design and Commitment for Field Review Schedule B and Assurance of Professional Field Review and Compliance Schedule C-B for seismic engineering.
- .3 Shop drawings: Submit shop drawings for all equipment as electronic files (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data
- .4 Closeout Submittals: Provide a minimum of four (4) mechanical operation and maintenance manuals and one digital copy, prepared by the TAB Contractor.
 - .1 Operation and maintenance manual approved by, and final copies deposited with the Consultant a minimum of 7-days before final inspection.
 - .2 Operation and maintenance manual to include but not limited to:
 - .1 Layman's description of the systems and associated controls.
 - .2 Operational instructions, servicing, maintenance, operation, and troubleshooting instructions for each item of equipment.
 - .3 Warranties
 - .4 Equipment manufacturer's performance datasheets indicating point of operation as left after commissioning is complete.
 - .5 Testing, adjusting, and balancing reports.
 - .6 List of suppliers and contact information.
- .5 Record Drawings:
 - .1 Consultant will provide 1 set of white prints at contractors cost to mark changes as work progresses and as changes occur. Use different colour waterproof ink for each service. Do not use pencil or black ink. Transfer information weekly to show work as actually installed. Drawings shall be available on a weekly basis for review by the Consultant.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Submit completed CAD record drawings with final Operating and Maintenance Manuals within two (2) weeks of substantial completion. Failure to submit drawings will result in the work being undertaken by the Owner and deducted from the Contractor's hold back amount.
 - .5 Cost to transfer record information onto reproducible media & Auto-CAD disks are this contractor's responsibility. Consultant will release drawings to contractor after signing a copyright form. Should the Contractor choose to utilise this consultant for transferring as built information, allow \$400 / sheet for all drawings in the construction set. This will cover costs for drafting time & printing costs.

1.6 Quality of Work

- .1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Consultant. Work, which does not conform to standards accepted by the Consultant and the trade, may be rejected by the Consultant. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.7 Metric Conversion

- .1 All units in this division are expressed in SI units.
- .2 On all submittals (shop drawings etc.) use the same SI units as stated in the specification.
- .3 Equivalent Nominal Diameters of Pipes - Metric and Imperial:
 - .1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment, and piping.
 - .2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

| Equivalent Nominal Diameter of Pipes | | | | | |
|--------------------------------------|--------------|-----|--------------|-----|--------------|
| mm | Inches (NPS) | mm | Inches (NPS) | mm | Inches (NPS) |
| 3 | 1/8 | 40 | 1-1/2 | 200 | 8 |
| 6 | 1/4 | 50 | 2 | 250 | 10 |
| 10 | 3/8 | 65 | 2-1/2 | 300 | 12 |
| 15 | 1/2 | 75 | 3 | 375 | 15 |
| 20 | 3/4 | 100 | 4 | 450 | 18 |
| 25 | 1 | 125 | 5 | 500 | 20 |
| 30 | 1-1/4 | 150 | 6 | 600 | 24 |

- .4 Metric Duct Sizes:
 - .1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.8 Drawings and Specifications

- .1 Should any discrepancy appear between drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of the plans, and specifications, obtain written clarification from the Consultant during the tender period. Without a written clarification, the better quality and/or greater quantity of work or materials shall be estimated, performed, and furnished within the tendered price.
- .2 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out and equipment will fit within the proposed locations without changes to building.

1.9 Cutting, Patching and Coring

- .1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves. All work shall be coordinated with other trades.
- .2 Obtain written approval from the Structural Consultant before cutting or burning structural members.

- .3 Provide X-ray of all required penetrations of the floor. X-ray use for locating in floor rebar and conduit to be done after normal working hours. Take necessary precautions to protect computer equipment when X-raying floors. Coordinate with Owner.

1.10 Compliance with Energy By-Law

- .1 All equipment installed on this project shall comply with:
 - .1 ASHRAE Standard 90.1 - 2016

1.11 Installation of Equipment

- .1 Pipe all equipment drains to building drains except systems containing glycol.
- .2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.
- .3 Maintain permanent access to equipment for maintenance.

1.12 Equipment and Materials

- .1 Refer to the attached List of Acceptable Manufacturers.
- .2 Where two or more products of the same type are required, products shall be of the same manufacturer.
- .3 Notify the Consultant in writing ten (10) days prior to the tender close, any materials or equipment specified which is not currently available or will not be available for use as called for herein. Failing this, the contract will assume that the most expensive alternate has been included in the tender price.
- .4 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.
- .5 The Contractor shall be fully responsible for any additional labour and materials required by any trades or other Contractors to accommodate the use of other than specified materials or equipment. The Contractor shall bear any and all costs for design/system modifications to accommodate the "alternate" equipment. Extras will not be approved to cover such work.
- .6 The Owner and/or Consultant holds the right to reject any equipment and/or materials that is different from that specified. It is the Contractor's responsibility to replace with the acceptable material or equipment as required.
- .7 All rotating equipment shall be supplied from the manufacturer with dynamically balanced shafts, wheels and any other rotating parts. Equipment supplier and manufacturer are responsible for any additional balancing, equipment, and materials replacement, and cost for addressing damages to the building, any systems, and equipment due to the supplied equipment improper balancing.
- .8 All equipment installed on this project shall comply with all applicable requirements including:
 - .1 BC Building Code and all referenced codes and standards
 - .2 BC Fire Code
 - .3 BC Plumbing Code

- .4 CSA Standards
- .5 Local Standards and Bylaws
- .6 Manufacturer requirements and recommendations
- .7 National Building Code and all referenced codes and standards
- .8 National Fire Code
- .9 National Plumbing Code
- .10 NFPA standards
- .11 ASHRAE Standard 90.1
- .12 ASHRAE Standards, Guidelines, Handbooks and Design Guides

1.13 Delivery, Storage and Handling

- .1 Storage and Handling Requirements:
 - .1 Store materials and equipment in accordance with the manufacturer's recommendations; in a clean, dry, well-ventilated area. Coordinate location of storage with the Owner.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .2 Protect equipment and open end duct with polyethylene covers and maintain equipment on crates until installation.
- .3 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.14 Firestopping and Smoke Seals

- .1 Provide firestopping system(s) to provide and maintain a fire resistance rating, as indicated on drawings and in accordance with UL, WH, ULC, cUL or FM design details for all mechanical work in Divisions 21, 22, 23 and 25.
- .2 For renovation projects, in addition to the necessary new penetrations, provide the firestopping for all existing mechanical assemblies where firestopping is damaged, discontinued or absent.
- .3 All firestop system installations must meet the requirements of CAN4-S115-M or ULC S-115-M Tested assemblies that provide a fire rating.
- .4 A manufacturer's direct representative (not distributor or agent) shall be on-site during the initial installation of firestop systems to train appropriate contractor personnel in correct selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

1.15 Access Doors

- .1 Provide access doors for maintenance or adjustment of all parts of the mechanical system.
- .2 Provide 300 mm x 300 mm minimum size for inspection and hand access.
- .3 600 mm x 600 mm minimum size, larger if indicated on drawings, where entry is required and access is difficult.

1.16 Escutcheons and Plates

- .1 Provide escutcheons and plates on all piping and ductwork passing through finished walls, floors, and ceilings.

1.17 Guarantee / Warranty

- .1 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance.

1.18 Balancing

- .1 The approved balancing agencies are: Blue Collar Group, Flotech Mechanical, Western Mechanical; K.D. Engineering.
- .2 Balance heat pumps, exhaust fans and air outlets to air quantities indicated on the drawings and in this specification. Where outlet quantities are not indicated, divide heat pump capacity equally among all outlets.
- .3 The balancer shall use appropriate air flow settings and control methods for single floor systems, accounting for the central system air volume diversity.
- .4 Submit a PDF copy of the report to the Consultant within two (2) weeks after substantial completion. Failure to submit the report within the specified time will result in the work being done by the Owner and the costs deducted from final payment.
- .5 Balancing shall be performed to the following:
 - .1 Air-Terminal Outlets: $\pm 10\%$
 - .2 Air-Central Equipment: $\pm 5\%$
 - .3 Hydronic-Pumps and Central Equipment: $\pm 5\%$
- .6 Provide a drop test of all fire dampers and a letter/certificate confirming this work.
- .7 Cooperate with the Balancing Agency as follows:
 - .1 Make any corrections as required by Balancing Agency.
 - .2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of record drawings and specifications for their use.
 - .3 Operate automatic control system and verify set points during balancing.
 - .4 Provide and install balancing valves, dampers, and other materials requested by the Balancing Agency and/or necessary to properly adjust or correct the systems to design flows, without additional cost to Owner.
 - .5 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, without additional cost to Owner.
 - .6 Allow in the contract price shaving of impellers as required to balance the pumps to design flow at operating condition.

1.19 Commissioning and Demonstration

- .1 Be responsible for the performance and commissioning of all equipment supplied and re-used under Divisions 22 and 23 including heat pumps, plumbing fixtures, and tanks.
- .2 At the conclusion of commissioning, demonstrate the operation of the systems to the consultant and then to the owner's operating staff.
- .3 At the completion of the commissioning, testing, balancing and demonstration submit to the consultant a letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.

1.20 System Cleaning and Chemical Treatment

- .1 Employ services of the existing building's water treatment firm or if there isn't one, a firm specializing in hydronic system chemical treatment. This firm shall submit a schedule of work to be performed, chemical types, and quantity to be used. At the completion of the chemical treatment, a report shall be submitted to outline the work performed, quality of water before and after the chemical treatment, amount and types of chemicals added. The report shall also include the details of procedures to be used by the building operator for water quality testing and chemical treatment.
- .2 Provide test kits as required along with adequate chemicals and reagents for one year of testing. Appropriate test kits will be provided to properly test each system installed under this contract.
- .3 Disinfect and flush all domestic cold, hot and recirculation water systems, provide a certificate for this work.

1.21 Flashing and Roof Curbs

- .1 Provide curbs, flash and counter flash as required where mechanical equipment passes through weather or waterproofed walls, floors and roofs.

1.22 Seismic Control

- .1 Provide seismic restraints for all required equipment, piping, and ductwork.
- .2 The Contractor shall retain the services of a qualified professional seismic engineer (Seismic Engineer) registered in the Province of British Columbia. The Seismic Engineer shall design and review the installation of all seismic restraints as well as mechanical equipment and mechanical system supports. The restraints and supports shall be specifically designed to fasten to the structure indicated in the contract documents and installed in the field. The complete design for these systems shall comply with all applicable building code requirements.
- .3 Seismic Engineer shall provide and submit to the Owner's Consultant Assurance of Professional Design and Commitment for Field Review Schedule B and Assurance of Professional Field Review and Compliance Schedule C-B for seismic engineering.
- .4 Piping ductwork and equipment shall be restrained in accordance with the latest edition of the Seismic Restraints Manual for Mechanical Systems produced by SMACNA, and the latest edition of the ASHRAE Application Handbook Chapter 49, Seismic Restraints.
- .5 Submit shop drawings of all seismic restraint details prepared and sealed by the seismic engineer. Prior to substantial completion, the seismic engineer shall visit the site and verify the seismic restraint installation as required to satisfy the Assurance of Professional Field Review and Compliance Schedule C-B of the Building Code.
- .6 The contractor shall obtain approval for the location of all restraint fixing points from the structural engineer, on site, prior to installation.
- .7 Where equipment is mounted on spring or resilient mounts for vibration isolation, it shall be the responsibility of the manufacturer of the mount to incorporate seismic restraint. These restraints shall be multi-directional as described in the guidelines specified above. Provide steel frame bases where necessary to achieve this and also avoid overturning. The manufacturer shall supply certificates, signed by a Professional Engineer registered within the jurisdiction, verifying the design of the seismic restraints in accordance with this section.

1.23 Vibration Isolation

- .1 Provide neoprene isolators for deflections 6mm ($1/4$ ") and under.

- .2 Provide either neoprene or steel spring isolators for deflections between 6mm and 12mm ($\frac{1}{2}$ ").
- .3 Provide steel spring isolators for deflections of 12mm ($\frac{1}{2}$ " and over.
- .4 Provide adjustable limit stops for spring isolation mounts on equipment with operating weights substantially different from the installed weights
- .5 All spring isolators shall be "open spring" unless otherwise stated. Seismically rated housed spring isolators may be used in lieu provided that they meet this project's requirements for seismic restraint.
- .6 Select isolators in accordance with equipment weight distribution to allow for an average deflection meeting or exceeding the specified deflection requirements and so that no isolator has a deflection less than 80% of the static deflection specified. A minimum of 4 isolators are required for each piece of equipment, unless specified otherwise. Refer to the minimum static deflection table contained in this Section.

1.24 Substantial and Total Performance

- .1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items, which are deficient.
- .2 A certificate of Substantial Performance will not be granted unless the following items are completed and available to the Owner's Consultant:
 - .1 Final Plumbing Inspection Certificate from the Authority having Jurisdiction.
 - .2 Schedule C-B for Fire Suppression and Fire Sprinkler Materials and Test Certificate.
 - .3 Schedule C-B for seismic engineering.
 - .4 Final Backflow Prevention test reports for all backflow devices.
 - .5 Fire stopping and Fire Damper test letter
 - .6 Draft Operating/Maintenance Manuals have been submitted for review.
 - .7 All mechanical systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation.
 - .8 Air and water systems have been balanced with draft report submitted to the Consultant.
 - .9 Operating and Maintenance demonstrations have been provided to the Owner.
 - .10 Record drawings have been submitted.
 - .11 All previously identified deficiencies have been corrected and accepted.
- .3 Prior to a Total Performance Inspection, provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:
 - .1 Submit final air and water balance reports.
 - .2 Submit final operating and maintenance manuals.
- .4 The Consultant shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers.
- .2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.
- .3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers listed.

2.2 Firestopping and Smoke Seals

- .1 Use the same manufacturer throughout the project and compatible materials for restoration work.
- .2 Provide fill material components for each firestopping system as needed. Use only components specified by the firestopping manufacturer for the designated fire-resistance-rated systems.
- .3 Acceptable manufacturers: 3M, Hilti, AD Firebarrier, Tremco

2.3 Electrical Motors

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable frequency drive (VFD) shall be inverter only rated.
- .3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.
- .4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.
- .5 Motors less than 3/4 hp shall be 120 V, 60 Hz, 1 phase. Motors 3/4 hp and larger shall be 3 phase at the indicated voltage.
- .6 All motors shall be 1800 rpm unless otherwise noted.
- .7 Provide motors complete with equipment except where indicated.
- .8 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
- .9 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.
- .10 Refer to electrical specifications, for voltage, frequency, and phase data. This shall take precedence over any reference in mechanical specification.
- .11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

2.4 Variable Frequency Drives (VFDs)

- .1 All VFDs installed on this project shall be from the same manufacturer. All VFDs and ancillary components must be procured by one supplier in order to assure an integrated system and one point of contact for service. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten years.
- .2 The VFD supplier shall provide warranty coverage for a minimum period of 5 years upon the date of project substantial completion.
- .3 VFD shall be UL508 listed as a complete assembly.
- .4 VFD shall be ULC listed and CSA (cUL) certified.
- .5 The VFD assembly and associated options and peripherals shall comply with the applicable requirements of the latest standards of ANSI, IEEE, NEMA, and the Canadian Electrical Code.
- .6 Each VFD, with all standard and optional features, shall be factory packaged in a ULC rated and listed enclosure most appropriate for each application and location, completely assembled and tested by the manufacturer in an ISO9001 facility.
- .7 VFDs sized less than 100 HP to be of the 6-pulse Pulse-Width Modulated (PWM) type to convert incoming fixed voltage/frequency to a fixed DC voltage. The PWM strategy shall incorporate a microprocessor to handle all logic functions as well as the complex, sine-coded PWM generating algorithms that control output stage switching.
- .8 The variable frequency drives shall convert three-phase, 60 Hz utility power to proportionally variable voltage and frequency, three-phase, AC power using the latest for step less motor speed control of one or more three-phase induction motors. The VFD output waveform to be the PWM or Vector type waveform producing smooth torque at low frequencies and low motor current harmonics.
- .9 Drives shall be capable of controlling and set up for either variable or constant torque loads, as follows:
 - .1 Variable torque: loads such as centrifugal fans, pumps and compressors
 - .2 Constant torque: loads such as positive displacement pumps and reciprocating or screw compressors
- .10 The VFD shall provide full rated output from a line of $\pm 10\%$ of nominal voltage.
- .11 The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute in every 10 minutes.
- .12 VFDs shall be capable of continuous full load operation under the following environmental operating conditions:
 - .1 -15°C to 40°C (5 to 104°F) ambient temperature.
 - .2 Altitude: 1100 (0 to 3550 ft) above sea level.
 - .3 Humidity less than 95%, non-condensing.
- .13 All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.
- .14 The VFD shall have cooling fans. The fans shall be replaceable without requiring VFD removal or removal of circuit boards. The VFD cooling fans shall cycle via thermal sensing not operate continuously.
- .15 Any options shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

- .16 VFD shall be provided with a NEMA 1 enclosure for indoor installations and NEMA 3R enclosure for outdoor installations.
- .17 Provide a 5% DC-link reactor on the positive and negative rails of the DC bus, reducing the level of harmonics reflected back into the building power system. Reactor shall be non-saturating (linear) providing full harmonic filtering throughout the entire load range.
- .18 Provide power line voltage surge protection by means of input Metal Oxide Varistors (MOVs).
- .19 The VFD shall have a TIA-485 (RS-485) port as standard. The standard protocols shall be BACnet.
- .20 The VFD shall be furnished with a Bypass mounted by the drive manufacturer. All VFD bypass configurations shall be ULc Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

2.5 Ductwork and Accessories

- .1 Provide ductwork constructed, reinforced, sealed, and installed to withstand 1-1/2 times the working static pressure.
- .2 Low Pressure Ductwork 500 Pa (2" W.G.) and under
 - .1 Supply ductwork and plenums on systems without terminal mixing boxes or air valves.
 - .2 Supply ductwork downstream from terminal mixing boxes or air valves.
 - .3 Outdoor air ductwork and plenums, unless noted otherwise.
 - .4 Return air ductwork and plenums, unless noted otherwise.
 - .5 Exhaust and relief air ductwork and plenums, unless noted otherwise.
 - .6 Low pressure insulated flexible ductwork shall be equal to Thermaflex Type M-KC.
 - .7 Connect outlet terminals to low pressure ducts with 900mm (36") maximum length of stretched flexible duct. Hold in place with strap or clamp, caulk sealed. Do not use flexible duct to change directions.
 - .8 Provide a flexible connection where low pressure ducts are connected to fan equipment, terminal boxes, or any other apparatus. Joint shall be screwed or bolted flexible gasketed joint, minimum 50mm (2") wide.
- .3 Duct Hangers
 - .1 Hangers and Supports to SMACNA standards
 - .2 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .3 Maximum size duct supported by strap hanger: 500 mm.
 - .4 Hangers: Galvanized steel angle with galvanized steel rods to SMACNA.
 - .5 Toggle hangers and/or strap hangers shall not be used.

- .6 Power actuated fasteners and “drop-in” anchors shall not be used for tension load applications such as pipe and duct hangers.
- .4 Duct Sealing
 - .1 Low Pressure Ductwork 500 Pa (2” W.G.) and under shall be SMACNA seal class A. Seal all supply, return and exhaust duct joints, longitudinal as well as transverse joints as follows:
 - .1 Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5 mm (1/16”) use heavy mastic type sealant.
 - .2 Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.
 - .3 Other Joints: Heavy mastic type sealant.
 - .2 Duct tapes as sealing method are not permitted, except on residential ductwork – minimum 2 wraps of 2” wide (50mm) foil duct tape is acceptable.
 - .3 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.
 - .4 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application, by the Consultant.

2.6 Dryer Lint Trap – Standard Appliance Type

- .1 Lint trap suitable for surface mount or drywall mount. No rough exposed edges
- .2 Galvanized steel assembly with cleanable stainless steel mesh screen attached to a clear plexiglass front cover. Cover to pull out for cleaning and held in place by two heavy duty magnets to create an air tight seal.
- .3 Lint trap approximately 180mm wide x 150mm long x 180mm high (7” x 6” x 7”)
- .4 Inlet collar 100mm (4”) diameter. Outlet collar 125mm (5”) diameter
- .5 Reversomatic #LT-250M-45 or equal

2.7 Dryer Lint Trap – Stacked Appliance Type

- .1 Lint trap suitable for surface mount on stacked washer/dryer application
- .2 Galvanized steel assembly with white enamel finish, cleanable stainless steel mesh screen attached to a pull out tray with clear plexiglass front cover. Positive lock to create an airtight seal.
- .3 Lint trap approximately 200mm wide x 700mm long x 90mm high (8” x 28” x 3-1/2”)
- .4 Inlet collar 100mm (4”) diameter. Outlet collar 125mm (5”) diameter
- .5 Reversomatic #LT-400-SD or equal

2.8 Access Doors

- .1 Drywall Surface: Extruded aluminum frame with gypsum board inlay and structural corner elements. Hinge to be concealed 2-point hinge, non-corroding with allen head cam latch.
- .2 Tile Surface: Universal design, stainless steel door (16ga) and stainless steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, allen head cam latch, #4 satin stainless steel finish.

- .3 Plaster Walls and Ceiling: steel door (14ga) and steel frame (14ga), door flush to frame edge, expansion casing bead and 75 mm wide galvanized lath surround recessed 18 mm to receive plaster, continuous concealed hinge, allen head cam latch, prime coat grey painted finish.
- .4 Fire Rated Walls:
 - .1 Non-combustible construction: Uninsulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 2 hour 'B' label.
 - .2 Combustible construction: Insulated steel door (20ga) for maximum 250°C rise after 30 minutes and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 1½ hour 'B' label.
- .5 Fire Rated Ceilings: 50mm Insulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed upswing self-closing hinge, L handle latch, white baked enamel finish, size 600mm x 600mm (24" x 24") ULC rated 2 hour 'B' label.
- .6 Ductwork: Ultra low leakage type, flat oval design, galvanized steel frame (22ga), double skin galvanized steel door (22 ga) with 25mm insulation fully enclosed in panel, bulb type seal integrally fastened to door, lever cam locks. Provide stainless steel in lieu of galvanized steel in stainless steel ductwork.

2.9 Identification

- .1 Identify piping with labels and flow arrows. Provide identification at 15m (50ft) maximum intervals, before and after pipes passing through walls, at all sides of tees, behind access doors. Use Brady B-500 vinyl cloth labels for non insulated pipes and B-350 for insulated pipes.
- .2 Provide 20mm (¾") diameter brass tags, secure to valve stems with key chain. Provide a valve directory at all mechanical rooms, in the O&M manuals and a digital copy cross referenced with any associated controls nomenclature.
- .3 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, cooling coil CC-1, pump P-1 with lamacoid plates having 6mm (¼") minimum letter size.

2.10 Piping

- .1 Pipe Material
 - .1 Refrigerant:
 - .1 ACR Copper.
 - .2 Condensate; Pumped Condensate:
 - .1 Steel Schedule 80, A120.
- .2 Pipe Connections
 - .1 Unless noted otherwise:
 - .1 NPS 1½ and less: screwed joint steel piping
 - .2 NPS 2: screwed joint for liquid systems, weld joint for air or gas systems.

- .3 NPS 2½ and larger: Weld or flanged piping including branch connections.
- .2 Use dielectric type couplings when joining dissimilar metal pipes.
- .3 Use lead free solder for soldering domestic water copper pipe.

2.11 Valves

- .1 General:
 - .1 Wherever possible all valves shall be of one manufacturer.
 - .2 Grooved valves are not acceptable.
 - .3 Grooved valves shall be of the same manufacturer as the adjoining couplings.
 - .4 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body. All valves must be suitable in all respects for service used.
 - .5 All valves shall have a Provincial CRN number which is current.
 - .6 Use non-rising stem valves only where there is insufficient clearance for stem to rise.
 - .7 Butterfly valves may only be used on heating water systems or heat recovery systems where the maximum design temperature does not exceed 82°C (180°F).
- .2 Ball Valves 2 NPS and under
 - .1 Forged brass body, threaded cap, chrome plated ball, PTFE seats, blow out proof stem, adjustable packing nut.
 - .2 Ball valves for isolation service shall have a large/full port.
 - .3 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.
 - .4 Screwed: Class 4140 kPa (600 psi) W.O.G.
 - .1 Toyo/Red & White 5044AB or equal.
- .3 Gate Valves 2 NPS and under:
 - .1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.
 - .2 Screwed: Class 2070 kPa (300 psi) W.O.G.
 - .1 Toyo/Red & White 298 or equal.
- .4 Gate Valves 2½ NPS and over:
 - .1 Cast iron body, rising stem, O.S. & Y, solid wedge disc, bronze trim, bolted bonnet.
 - .2 Flanged: Class 1033 kPa (150 psi) W.O.G.
 - .1 Toyo/Red & White 421 or equal.
- .5 Globe Valves 2 NPS and under:
- .6 Bronze body, stainless steel disc, union bonnet
 - .1 Screwed: Class 2760 kPa (400 psi) W.O.G.
 - .1 Toyo/Red & White 214 or equal.
- .7 Globe Valves 2½ NPS and over:
- .8 Cast iron body, rising stem, O.S. & Y cast iron disc, brass seat
 - .1 Flanged: Class 1380 kPa (200 psi) W.O.G.
 - .1 Toyo/Red & White 400 or equal.

- .9 Check Valves 2 NPS and smaller:
 - .1 Bronze swing check with bronze disc capable of being reground
 - .2 Screwed: Class 13880 kPa (300 psi) W.O.G.
 - .1 Toyo/Red & White 238 or equal.
- .10 Check Valves 2½ NPS and over:
- .11 Cast iron body, bolted cover, bronze seat, cast iron disc
 - .1 Flanged: Class 1380 kPa (200 psi) W.O.G.
 - .1 Toyo/Red & White 435 or equal.

2.12 Duct and Breeching Insulation

- .1 Exposed Rectangular Ducts: External rigid Insulation, service temperature 5°C to 232°C (41°F to 450°F), mineral fiber board for low and medium temperature applications, all service aluminum foil-scrim kraft (FSK) vapour barrier jacket with glass fibre reinforcement, factory applied.
 - .1 Density 36kg/m3 (2.25 PCF), Minimum RSI 0.76/25mm (R 4.3/in)
- .2 Round Ducts and Concealed Rectangular Ducts: External flexible insulation, service temperature 5°C to 232°C (41°F to 450°F), glass fiber or mineral fiber flexible blanket for low and medium temperature applications, all service aluminum foil-scrim kraft (FSK) vapour barrier jacket with glass fibre reinforcement, factory applied.
 - .1 Density 12kg/m3 (0.75PCF), Minimum RSI 0.49/25mm (R 2.8/in) (installed)
- .3 Acoustic Lining Ducts: Internal flexible duct liner, flexible mineral fiber blanket, for low and medium temperature acoustical applications, airstream surface faced with a black mat bonded to the fibreglass substrate, air velocity rating 25.4 m/s (5,000 ft/min)
 - .1 Density 24kg/m3 (1.5 PCF), Minimum RSI 0.74/25mm (R 4.2/in)
- .4 Acoustic Lining Plenums: Internal rigid duct liner, rigid mineral fiber board, for low and medium temperature acoustical applications, airstream surface faced with a black mat bonded to the fibreglass substrate, air velocity rating 25.4 m/s (5,000 ft/min)
 - .1 Density 48kg/m3 (3 PCF), Minimum RSI 0.76/25mm (R 4.3/in)
- .5 Breeching Insulation: External semi-rigid insulation, service temperature up to 538°C (1000°F), glass fiber or mineral fiber flexible blanket for high temperature applications.
 - .1 Density 25kg/m3 (1.6PCF), Minimum RSI 0.25/25mm (R 1.4/in)
- .6 Finish Jackets
 - .1 Thermocanvas Jacket: fire rated, 170g (6 oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.
 - .2 Utility Finish: Over rigid insulation for rectangular ductwork and flexible insulation for round ductwork. Apply continuous metal corner bead to all corners. Adhere vapor retarder tape over all joints and breaks in vapor retarder, and at all corners.
 - .3 Aluminum Jacket: 51 mil (22 ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm (2") end laps with factory applied protective liner on interior surface.

2.13 Preformed Pipe Insulation

- .1 Low Temperature, piping service temperature -40°C to 5°C (-40°F to 41°F)

- .1 Preformed and pre-slit flexible foamed elastomeric or closed cell insulation with self-adhesive self seal or lap seal joints, maximum "K" value at 24°C (75°F) = 0.039 W/m.°C (0.27 Btu.in/hr.ft2.°F)
- .2 Low to Intermediate Temperature, 5°C to 315°C (41°F to 599°F)
 - .1 Preformed insulation, fine fibrous glass or formed mineral fibre pipe insulation with all service jacket vapour retarder (ASJ). ASJ shall be re-enforced with glass fibre, factory applied with pressure sensitive lap closure. Maximum "K" value at 38°C (100°F) = 0.035 W/m.°C (0.24 Btu.in/hr.ft2.°F)
- .3 Finish Jackets
 - .1 Thermocanvas Jacket: fire rated, 170g (6 oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.
 - .2 PVC Finishing Jacket: white, UV resistant, for indoor or outdoor applications, 25/50 fire class, minimum 0.50 mm (0.02") thick.
 - .3 Aluminum Jacket: 0.51 mm (22 ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm (2") end laps with factory applied protective liner on interior surface.

2.14 Equipment Insulation

- .1 Low Temperature, piping service temperature -40°C to 5°C (-40°F to 41°F)
 - .1 Flexible foamed elastomeric or closed cell insulation with self-adhesive seal or lap seal joints, maximum "K" value at 24°C (75°F) = 0.039 W/m.°C (0.27 Btu.in/hr.ft2.°F)
- .2 Low to Intermediate Temperature, 5°C to 315°C (41°F to 599°F)
 - .1 Fine fibrous glass or mineral fibre insulation. Maximum "K" value at 38°C (100°F) = 0.035 W/m.°C (0.24 Btu.in/hr.ft2.°F)

2.15 Seismic Cable Restraints

- .1 Galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
- .2 Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.

2.16 Vibration Isolation

- .1 Neoprene Washer/Bushing
 - .1 A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Use washer/bushing only on light-weight equipment.
 - .1 Mason HG hemi grommet or equal
- .2 Neoprene Pad Isolators
 - .1 Neoprene or neoprene / steel / neoprene pad isolators. Minimum static deflection 2.5 mm (0.1") or greater.
 - .1 Mason WMSW or equal
- .3 Rubber Floor Mounts
 - .1 Bridge bearing neoprene mountings. Minimum static deflection of 5mm (0.2") or greater and all directional seismic capability.

- .1 Mason RAA or ND or equal
- .4 Spring Floor Mounts
 - .1 Spring isolators built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 6mm (1/4") travel in all directions before contacting the resilient snubbing collars.
 - .2 Molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the baseplate and the support.
 - .3 Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
 - .1 Mason SSLFH or equal
- .5 Spring Hangers
 - .1 Hangers shall consist of rigid steel frames containing minimum 32mm (1 1/4") thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom.
 - .2 Provide a combination rubber and steel rebound washer as the seismic upstop for suspended piping, ductwork, and equipment. Rubber thickness shall be a minimum of 6mm (1/4"). Colour coded springs, rust resistant, painted box type hangers.
 - .3 To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring.
 - .1 Mason HD, HS or equal
- .6 Acceptable Manufacturers, Korfund, Vibro-Acoustics

3. EXECUTION

3.1 Painting Repairs and Restoration

- .1 Do painting in accordance with Division 09 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.
- .4 Clean exposed bare metal surfaces supplied under Divisions 21, 22, 23 and 25. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.

3.2 Demonstration

- .1 Supply tools, equipment, personnel to demonstrate and instruct the operating, and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Use operation and maintenance manual, record drawings, and audio visual aids as part of instruction materials.

3.3 Firestopping and Smoke Seals

- .1 The Owner's Consultant shall conduct mandatory destructive reviews for each type of installation. Destructive testing shall be at the discretion of the Owner's Consultant and Authority having jurisdiction.

- .2 Allow for destructive testing of 5% of fire stopping applications. Should installations not conform to manufacturer's listed assembly, an additional 25% of installations may be destructively tested and should there be more failures, the contractor will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the project.
- .3 Tag all penetrations and every 3 meters of joint seal with printed tags
 - .1 Tags shall indicate:
 - .1 Product
 - .2 System #
 - .3 Date installed
 - .4 Installed by: (name and phone number of subcontractor)
 - .5 Re-penetrated by & Date
 - .2 Tags shall state:
 - .1 CAUTION! FIRESTOP - DO NOT REMOVE, PUNCTURE OR DISCONTINUE UNLESS PREPARED TO RE-SEAL IMMEDIATELY WITH SPECIFIED PRODUCT
- .4 Comply with manufacturer's instructions for installation of through-penetration joint materials.
- .5 Where possible, use metal sleeves for floor penetrations to prevent/mitigate the consequences of leakage or flooding.
- .6 Perform under this section patching and repairing of firestop caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.4 Ductwork and Accessories

- .1 Fabricate ductwork in accordance with:
 - .1 SMACNA Duct Construction Standards – metal and flexible
 - .2 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems
 - .3 NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
 - .4 NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 Prior to fabrication of ductwork, check all ceiling spaces and heights and conflicts with other trades.
- .3 Duct sizes indicated are inside clear dimensions. For acoustically lined or internally insulated ducts allow for insulation thickness and maintain interior clear dimensions indicated.
- .4 Provide fire dampers where ducts cross fire separations. Fire dampers shall be ULC listed and "dynamic"; rated to close under airflow. Refer to architectural drawings for fire separation ratings and locations.
- .5 Provide balancing dampers where indicated on drawings and at points on low pressure supply, return and exhaust ducts where branches are taken from larger ducts.
- .6 Provide return air openings and/or insulated sound traps where indicated.
- .7 Provide acoustical seal around ducts and sound traps at penetration through sound baffles.
- .8 Modify ceiling system where required to accommodate grilles and diffusers.

- .9 Size round ducts, installed in place of rectangular ducts, from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by permission from the Consultant.
- .10 Exposed round ductwork to be spiral lock seam type only.
- .11 Provide duct hangers and supports in accordance with SMACNA manuals.
- .12 Confirm the existing base building standards prior to submitting tender.
- .13 Ductwork shall be galvanized steel unless noted otherwise.
- .14 Duct support shall be:
 - .1 Up to 750mm duct size: angle size 25x25x3 mm with 6mm rod size
 - .2 751 to 1050mm duct size: angle size 40x40x3 mm with 6mm rod size
 - .3 1051 to 1500mm duct size: angle size 40x40x3 mm with 10mm rod size
 - .4 1501 to 2100mm duct size: angle size 50x50x3 mm with 10mm rod size
 - .5 2101 to 2400mm duct size: angle size 50x50x5 mm with 10mm rod size
 - .6 2401 and over duct size: angle size 50x50x6 mm with 10mm rod size
- .15 Upper hanger attachments shall be:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps.

3.5 Dryer Lint Trap – Stacked Washer/Dryer Type

- .1 Mark Lint Trap position on the dryer, the lint trap inlet collar, and the dryer exhaust must be aligned. Fix double sided foam tape on the bottom surface of the lint trap, tape spacing equally before fixing into place.
- .2 Always use rigid duct at inlet and outlet connections.

3.6 Access Doors

- .1 Provide all access doors required to access work installed by Divisions 21, 22, 23 and 25. Be responsible for coordinating locations, cutting opening and installing panels. Any secondary supports, blocking etc. will be by the ceiling or wall contractor.
- .2 Ensure that equipment is within view and accessible for operating, inspecting, adjusting, servicing without using special tools.

3.7 Piping

- .1 Pipe Hangers and Supports
 - .1 Provide hangers and supports to secure equipment in place, prevent vibration, protect against damage from earthquake, maintain grade, provide for expansion and contraction, and accommodate insulation.
 - .2 Natatorium: All hangers and supports shall be hot dipped galvanized and painted in place in the Natatorium.
 - .3 Provide galvanized hangers and supports for all piping except hangers and supports shall be copper plated or epoxy coated for copper piping.
 - .4 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.

- .5 Toggle hangers and/or perforated strap hangers shall not be used for pipe hangers.
- .6 Power actuated fasteners and “drop-in” anchors shall not be used for tension load applications such as pipe hangers.
- .7 Provide ring type hangers for piping up to NPS 1½ and clevis type hangers for piping over NPS 1½.
- .2 Pressure testing
 - .1 Advise Consultant or project manager 48 hours minimum prior to performance of pressure tests.
 - .2 Hydrostatic test: 150% of working pressure, but not less than 860 kPa (125 psig). For PP-R piping, do not exceed 1034 kPa (150 psi). For PEX piping, do not exceed 690 kPa (100 psi). Maintain test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
 - .3 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
 - .4 Conduct tests in presence of construction manager or project manager.
 - .5 Examine all joints for leaks and remake all leaking joints with new materials. Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.
 - .6 Insulate or conceal work only after approval and certification of tests by authorities.
 - .7 Pressure test all gas piping in accordance with CSA B149.1. Purge all piping after pressure tests in accordance with CSA B149.1.
 - .8 Submit copies of pressure test reports for all sections of piping.

3.8 Pipe Support Spacing

| Material | Maximum Pipe Size NPS | Minimum Rod Diameter mm (in) | Maximum Rod Length mm (in) | Maximum Spacing m (ft) |
|---------------------|--------------------------|---------------------------------|-------------------------------|---------------------------|
| Copper And Steel | up to 3/4 | 9 (3/8) | n/a | 1.5 (5) |
| | 1 | 9 (3/8) | n/a | 1.85 (6) |
| | 1 1/4 | 9 (3/8) | n/a | 2.15 (7) |
| | 1 1/2 to 2 | 9 (3/8) | n/a | 2.5 (8) |
| | 2-1/2 to 3 | 12 (1/2) | 635 (25) | 2.75 (9) |
| | 4 to 5 | 16 (5/8) | 785 (31) | 3.7 (12) |
| Steel | 6 | 20 (3/4) | 940 (37) | 5.2 (17) |
| Steel | 8 to 12 | 22 (7/8) | 1090 (43) | 5.8 (19) |

- .1 For pipe materials other than listed, refer to manufacturers recommendations for maximum spacing requirements.
- .2 For rod lengths in excess of the tabulated maximum rod length, reinforcing is required per SMACNA Seismic Restraint Manual or the Seismic Engineers written instruction.
- .3 Expansion Compensation
 - .1 Provide structural work and equipment required for expansion and contraction of piping. Provide anchors, guides, and expansion joints as required to adequately protect the piping systems.

- .2 Provide expansion compensation for all closed piping systems including but not limited to: heating water, chilled water, steam and condensate, closed condenser water systems, and all other closed piping systems that operate at varying temperatures. Expansion compensation may be eliminated from open systems such as domestic cold, domestic hot, domestic hot recirculating systems.
- .3 All piping shall be anchored and supported in such a manner that strain and/or weight does not come upon any apparatus and pipe branch connections. Expansion joints and compensators shall be installed and guided as per manufacturer's recommendations. All equipment shall be connected with unions or flanges to provide for easy removal. Where piping passes through walls or floor slabs, the sleeves shall be of sufficient size to accommodate the expansion and the pipe insulation, without binding or crushing the insulation or preventing the expansion of the piping.

3.9 Valves

- .1 Install valves in accessible locations with stems upright or angled 45° above horizontal unless approved otherwise. Valves must be accessible without removing adjacent piping.
- .2 Provide stem extensions on all insulated valves.
- .3 Provide ball valves in piping 2 NPS and smaller and butterfly valves or gate valves in piping 2½ NPS and larger for shut-off, equipment isolation, throttling, bypass or manual flow control services. Ball valves used for shut-off/isolation shall be full port.
- .4 Throttling valves are not to be used for shut-off; additional valves shall be installed for isolation purposes.
- .5 Provide isolation valves at branch take-offs, to isolate each piece of equipment, upstream of all meters, gauges, automatic air vents, and as indicated.
- .6 Provide isolation valves in all systems such that floor by floor for horizontal systems, all risers in vertical systems and zone areas on a large horizontal system can be isolated.
- .7 Use swing or soft seated spring loaded check valves in horizontal and vertical upflow pipes and on the discharge of pumps. Spring loaded water check valves shall be located eight (8) pipe diameters downstream of pumps or elbows. Use silent check valves on discharge of pumps and in vertical pipes with downward flow, and as indicated.
- .8 Do not install balancing or throttling valve on discharge of pumps equipped with VFD. Install pressure ports for flow measurement.

3.10 Duct Insulation Minimum Thickness Table (ASHRAE 90.1 Zone 5 and 6)

| Rigid Exterior Duct Insulation | | | | |
|--|-------------|-------------------|---------------------|----------|
| Duty | Plenum(4) | Duct Location | | |
| | | Interior | | Exterior |
| | | Conditioned Space | Unconditioned Space | |
| Minimum Insulation Thickness in mm (in.) | | | | |
| Cooling Only Air Supply | 25 (1") | 25 (1") | 40 (1-1/2") | 50 (2") |
| Heating or H/C Air Supply | 25 (1") | 25 (1") | 40 (1-1/2") | 75 (3") |
| Outdoor Air Supply | 40 (1-1/2") | 40 (1-1/2") | 40 (1-1/2") | 0 |
| Return Air | 0 | 0 | 40 (1-1/2") | 75 (3") |
| Exhaust Air (1)(2) | 0 | 0 | 25 (1") | 25 (1") |
| Tempered Air Supply or Makeup Air | 0 | 0 | 40 (1-1/2") | 75 (3") |

| Rigid Exterior Duct Insulation | | | | |
|--|-----------|-------------------|---------------------|----------|
| Duty | Plenum(4) | Duct Location | | |
| | | Interior | | Exterior |
| | | Conditioned Space | Unconditioned Space | |
| Minimum Insulation Thickness in mm (in.) | | | | |
| Mixed Air (3) | 25 (1") | 25 (1") | 40 (1-1/2") | 75 (3") |
| See note (3) for internal duct liner | | | | |

Note (1): Air temperatures 15°C to 49°C (60°F to 120°F)

Note (2): Provide 40mm (1-1/2") flexible insulation on all exhaust air ductwork from outside wall or roof to damper but a minimum of 1.5 m (5 ft.) inside building.

Note (3): Mixed Air includes tempered air downstream of heat recovery units.

Note (4): Plenums located outside the building shall be insulated to the values listed in the exterior column.

Note (5): Provides 1 hour fire rating. Thickness shall be doubled for 2 hour applications

Note (6): Factory installed ductwork and plenums provided with equipment need not comply with this table provided they meet the requirements of the relevant CSA Standard for that equipment and is insulated to RSI 0.58 (R3.3) or greater. Refer to NECB article 5.2.12.1 for relevant CSA Standards.

3.11 Duct Finishes Table

.1 Conform to the following:

| Duty | Rectangular Duct | | Round Duct | |
|--|------------------|-----------|-----------------|-----------|
| | Type | TIAC Code | Type | TIAC Code |
| Indoor concealed | None | None | None | None |
| Indoor exposed in mechanical room and elsewhere except utility areas | Canvas Jacket | CRF/1 | Canvas Jacket | CRD/1 |
| Indoor exposed in utility areas, parkade, etc. | Utility Finish | CRF/2 | Utility Finish | CRD/2 |
| Outdoor exposed to precipitation | Aluminum Jacket | CRF/3 | Aluminum Jacket | CRD/3 |

3.12 Piping Insulation Minimum Thickness Schedule

| Type of System | Design Operating Temperature Range °C (°F) | Thermal Conductivity of Insulation | | Nominal Pipe Diameter (NPS) | | | | |
|----------------|--|------------------------------------|---------------------------------|---|-----------|----------|--------|-----|
| | | Conductivity Range W/m.°C | Mean Rating Temperature °C (°F) | Runouts ≤ 1 | 1 to 1.25 | 1.5 to 3 | 4 to 6 | ≥ 8 |
| | | | | Minimum Thickness of Piping Insulation (mm) | | | | |
| Refrigeration | <5 (41) | 0.029-0.037 | 10 (50) | 25 | 25 | 25 | 25 | 40 |

Note: Where the thermal conductivity of insulation is greater than the range specified above, increase the thickness by the ratio of U2/U1.

U2 = proposed insulation "k" value at the table mean rating temperature.

U1 = upper range limit "k" value from the table above.

Note: Where thermal conductivity of insulation is less than the range specified above, the thickness may be decreased by the ratio of U2/U1.

U2 = proposed insulation "k" value at the table mean rating temperature.

U1 = lower range limit "k" value from the table above.

All exterior piping or piping located outside the building insulation, for all pipe sizes shall be:

Climatic Zone 4 100mm (4") thickness

Climatic Zones 5,6 & 7A 112mm (4 ½") thickness

Climatic Zone 7B & 8 137mm (5 ½") thickness

3.13 Piping Finish Schedule

- .1 Indoors concealed; factory finish
- .2 Indoors exposed in mechanical room and elsewhere; canvas jacket
- .3 Indoors, exposed in utility areas, parkade, etc.; PVC jacket
- .4 Outdoors; aluminum jacket

3.14 Seismic Cable Restraints

- .1 Cables must not be allowed to bend across sharp edges.
- .2 Cable assemblies shall suit installation type:
 - .1 Ceiling and at the clevis bolt
 - .2 Between the hanger rod nut and the clevis
 - .3 Clamped to a beam

3.15 Vibration Isolation

- .1 Neoprene Washer/Bushing
 - .1 Isolate variable frequency drive controller using neoprene washer/bushing isolators or soft grommets such that structure borne noise transmission to occupied space is less than airborne noise transmission.

- .2 Rubber Floor Mounts
 - .1 Mount in-line pumps on two (2) rubber floor mount isolators under each support foot.
 - .2 For equipment mounted on a slab on grade mount on rubber floor mount isolators unless otherwise specified.
 - .3 Provide protection of the rubber element from contact with oil in the mechanical room.
- .3 Spring Floor Mounts
 - .1 Isolate all floor or pier mounted equipment on spring floor mount isolators, unless otherwise specified.
- .4 Spring Hangers
 - .1 Locate isolation hangers as near to the overhead support structure as possible.
 - .2 Installation shall permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
 - .3 All discharge ductwork runs for a distance of 15m (50') from the connected equipment shall be isolated from the building structure by means of spring hangers. Spring deflection shall be a minimum of 19mm (0.75").
- .5 Minimum Static Deflection Schedule

| Equipment | Equipment Supported By: | |
|--|-------------------------|---------------|
| | Slab on Grade | Elevated Slab |
| Hot Water Boilers | Nil | 3mm (1/8") |
| Heat Pumps (see Note 5) | 9mm (3/8") | 38mm (1 1/2") |
| Pumps: | | |
| In-line under 1.5kW (2HP) | 1mm (1/16") | 3mm (1/8") |
| In-line 1.5kW (2 HP) to 11.5kW (15 HP) | 3mm (1/8") | 5mm (1/4") |
| In-line over 11.5kW (15 HP) | 3mm (1/8") | 9mm (3/8") |
| Base mounted under 5.5kW (7.5 HP) | 5mm (1/4") | 19mm (3/4") |
| Base mounted 5.5kW (7.5 HP) and greater | 19mm (3/4") | 38mm (1 1/2") |
| Fans, Blowers & Packaged H & V Units: | | |
| Under 0.5 HP | 1mm (1/16") | 1mm (1/16") |
| 0.5 HP to 7.5 HP | 25mm (1") | 25mm (1") |
| 7.5 HP to 40 HP - up to 400 rpm | 38mm (1 1/2") | 38mm (1 1/2") |
| 7.5 HP to 40 HP - over 400 rpm | 25mm (1") | 25mm (1") |

- .6 Notes:
 - .1 Table indicates required static deflection of isolators for all fans regardless of power rating and for all other motor driven equipment over 0.37kW (0.5 HP).
 - .2 Advise consultant of equipment not contained in this table and obtain clarification as to the isolation performance requirements.
 - .3 Steel spring isolators shall be used for all deflections 12mm (1/2") and over.
 - .4 Neoprene isolators shall be used for deflections 6mm (1/4") and under.
 - .5 Use housed spring isolators for heat pump.

END OF SECTION

1. GENERAL

1.1 Related Requirements

- .1 This section of the specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 References

- .1 ASME
 - .1 ASME B16.22-[18], Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-[16], Cast Copper Alloy Pipe Flanges and Flanged Fittings, and Valves: Class 150, 300, 600, 900, 1500, and 2500.
 - .3 ASME B16.26-[18], Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-[16], Refrigeration Piping, and Heat Transfer Components.
- .2 ASTM International
 - .1 ASTM A126-[19], Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - .2 ASTM A307-[14e1], Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .3 ASTM B280-[18], Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 American Welding Society, Inc. (AWS): Brazing Handbook
 - .1 A5.8/A5.8M [19] Standard Specification for Filler Metals for Brazing and Braze Welding.
 - .2 D10.12M/D10.12 [00]. Guide for Welding Mild Steel Pipe.
- .4 CSA Group
 - .1 CSA B52-[13], B52 Package, Mechanical Refrigeration Code.
- .5 Environment Canada (EC)
 - .1 EPS 1/RA/1-[96], Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.3 Permits and Qualifications

- .1 Ensure that a permit is obtained before anyone commences to install or alter any refrigeration system.
- .2 Every person who installs or makes alterations or repairs to a refrigeration system shall be the holder of a valid and subsisting refrigeration contractor's licence and all persons repairing equipment with ODS/CFC's shall have completed an Environment Canada approved training program.

1.4 Performance Requirements

- .1 Line test pressure for refrigerant R-410A:
 - .1 Suction lines for air-conditioning applications: 300 psig.
 - .2 Suction lines for heat-pump applications: 535 psig.

- .3 Hot-gas and liquid lines: 535 psig.

1.5 Administrative Requirements

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning work of this Section, with contractor's representative in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building construction subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.

1.6 Action and Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Submit [2] copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.7 Closeout Submittals

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

1.8 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect refrigerant piping, fittings, and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.9 Electrical Wiring

- .1 Refrigeration trade shall carry out and be responsible for all refrigeration control wiring unless otherwise noted, including all line voltage wiring from disconnect switch to units.
- .2 Power wiring to units to be by the Electrical Contractor.

2. PRODUCTS

2.1 Copper Piping

- .1 Processed for refrigeration installations, deoxidized, dehydrated, and sealed.
- .2 Hard copper: to ASTM B280, type ACR.
- .3 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 Steel Piping

- .1 ASTM A 53/A 53M, black steel with plain ends.

2.3 Fittings

- .1 Service: to suit the refrigerant design pressure, but minimum 2800 kPa [406 psig].
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22 or cast bronze to MIL-F-1183E.
 - .2 Joints: copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150, and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts, and washers: to ASTM A307, heavy series.
 - .4 Steel flanges and flanged fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.
- .5 Welded:
 - .1 Fittings: wrought-steel to ASTM A 234/A 234 M.
 - .2 Joints: filler material to AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- .6 Long radius type for elbows and return bends.

2.4 Joints

- .1 Brazing materials shall be SIL-FOS-15 phosphor-copper-silver alloy for copper piping jointed by copper fittings and silver solder for brass fittings.
- .2 Flexible connections: 3/8" nominal or less shall be made using coiled soft copper tubing. For larger sizes, use seamless flexible bronze hose with bronze wire braid covering. Use factory sealed neoprene jacket unit where freezing may occur.

2.5 Pipe Sleeves

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.6 Valves

- .1 Diaphragm Packless Valves:
 - .1 Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - .2 Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - .3 Operator: Rising stem and hand wheel.
 - .4 Seat: Nylon.
 - .5 End Connections: Socket.
 - .6 Working Pressure Rating: 500 psig.
 - .7 Maximum Operating Temperature: 275 deg F.
- .2 Packed-Angle Valves:
 - .1 Body and Bonnet: Forged brass or cast bronze.
 - .2 Packing: Molded stem, back seating, and replaceable under pressure.
 - .3 Operator: Rising stem.
 - .4 Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 - .5 Seal Cap: Forged-brass or valox hex cap.
 - .6 End Connections: Socket.
 - .7 Working Pressure Rating: 500 psig.
 - .8 Maximum Operating Temperature: 275 deg F.
- .3 Service Valves:
 - .1 Body: Forged brass with brass cap including key end to remove core.
 - .2 Core: Removable ball-type check valve with stainless-steel spring.
 - .3 Seat: Polytetrafluoroethylene.
 - .4 End Connections: Copper spring.
 - .5 Working Pressure Rating: 500 psig.
- .4 Solenoid Valves:
 - .1 Copper or brass body with flared or threaded ends.
 - .2 With field replaceable coil, serviceable without removing valve from line.
 - .3 Coil voltage to suit field requirements.
 - .4 Provide upstream of thermostatic expansion valves.
 - .5 Acceptable Products: Alco 240 RA series.
- .5 Charging and Purging Valves
 - .1 General-purpose type with brass body, flared or solder ends, and removable valve core.

- .2 Valves to be the same size as line size into which they are connected or 12 mm [$\frac{1}{2}$ "] whichever is the larger.
- .3 Valve complete with a removable seal cap chained to the valve body.
- .4 Acceptable Products: Henry Standard type, Mueller Linemaster Special
- .6 Pressure Relief Valves
 - .1 Comply with ASME Boiler and Pressure Vessel Code; UL listed.
 - .2 Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 - .3 Piston, Closing Spring, and Seat Insert: Stainless steel.
 - .4 Seat Disc: Polytetrafluoroethylene.
 - .5 End Connections: Threaded.
 - .6 Working Pressure Rating: 400 psig.
 - .7 Maximum Operating Temperature: 240 deg F.
 - .8 Set valves in accordance with CSA B52.
- .7 Check Valves
 - .1 Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections.
 - .2 Direction of flow shall be legibly and permanently indicated on the valve body.
 - .3 Working Pressure Rating: 500 psig.
 - .4 Maximum Operating Temperature: 275 deg F.

2.7 Sight Glass

- .1 Provide sight glass in liquid line following filter drier.
- .2 Sight glass shall be combination moisture-liquid indicator and with a protective removable cap.
- .3 Sight glass to be fitted in-line.
- .4 Acceptable Products: Henry Dri-Vue, Mueller Vuemaster, Sporlan See All.

2.8 Access Fittings

- .1 Provide Schrader access fittings in each suction connection from an evaporator, located adjacent to the superheat sensing element of the expansion valve.
- .2 Fittings to be used for checking the superheat of the suction gas.
- .3 Access fitting shall be soldered into a tee and shall be complete with a quick-seal cap.

2.9 Filter Driers

- .1 Provide a filter drier in the liquid line from the condenser. Shut-off valves shall be installed on each side of drier and sight glass.
- .2 Filter drier shall be selected to have a pressure drop of not more than 13 kPa [2 psig] when passing 150% of the system flow rate.
- .3 Removable core with flare connections.
- .4 Desiccant drier material shall be replaceable.
- .5 Acceptable Products: Alco Extra-Klean, Catch-All, Henry Dri-Cor, Mueller Drymaster II, Sporlan.

2.10 Refrigerant Driers

- .1 Driers shall be in-line or angle type with copper or brass shell.
- .2 Desiccant drier material shall be replaceable.

2.11 Strainers

- .1 Refrigerant strainers shall be angle replaceable cartridge type with brass shell.
- .2 Cartridge material and screen size shall be suitable for refrigerant and piping material utilized in the system.

2.12 Refrigerant Tube Supports

- .1 Middle Attachments (Rod):
 - .1 Carbon steel black (electro-galvanized for mechanical rooms) continuous threaded rod - Anvil Fig. 146 Myatt Fig. 434.
- .2 Pipe Hangers:
 - .1 Uninsulated pipe, up to 1-1/4" - Grinnell 97C.
 - .2 Insulated pipe, up to NPS 1 - Grinnell fig. 269 or Myatt fig. 120.
 - .3 Insulated pipe, NPS 1-1/4 - Anvil Figs. 65 or 260 or Myatt Figs. 122 or 124.
 - .4 Maximum horizontal pipe hanger spacing:

| Pipe Size | Maximum Spacing | Rod Diameter |
|----------------|-----------------|--------------|
| up to NPS ¾ | 1.5 m [5 ft] | 10 mm [3/8"] |
| NPS 1 & NPS 1¼ | 1.8 m [6 ft] | 10 mm [3/8"] |

- .3 Wall Supports:
 - .1 Horizontal pipe adjacent to wall; angle iron wall brackets with specified hangers.
 - .2 Vertical pipe adjacent to wall; exposed pipe wall support for lateral movement restraint – Anvil Fig. 262.
- .4 Note:
 - .1 On insulated piping, where the insulation is specified to have a continuous sealed vapour barrier, (cold services) install oversized clevis hangers and insulation protection shields (Anvil Fig. 167 or equivalent) with metal thickness and lengths as recommended by Anvil.
 - .2 Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).
 - .3 Cold Services - refrigerant suction lines.

2.13 Evaporator Drains

- .1 Each evaporator shall be fitted with a copper drain line, size as shown.
- .2 Drain line shall be complete with a running trap.

2.14 Flexible Connections

- .1 Braided tin-bronze convoluted flexible connections.
- .2 End Connections: Socket ends.

- .3 Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
- .4 Design pressure 3447 kPa [500 psig] at 121C [250F].
- .5 Use only at or near compressors where it is not physically possible to absorb vibration within piping configuration.

2.15 Pipe Insulation

- .1 Refer to Section 23 07 19 HVAC Piping Insulation.

3. EXECUTION

3.1 Examination

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

3.2 Manufacturer's Instructions

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

3.3 General

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

3.4 Brazing Procedures

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.
- .4 Special precautions shall be taken to prevent the overheating of copper tube.

3.5 Piping Installation

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
 - .2 Braze all copper pipe joints. Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
 - .1 Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - .2 Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
 - .3 Tubing shall be cut square and have all burrs removed.

- .4 Piping shall be kept meticulously clean. All cleaned piping in the process of erection, whether installed or awaiting installation shall be capped or plugged.
- .5 Piping shall be installed in true vertical and horizontal planes close to walls and ceilings, with specified pitch. Provide suitable offsets to account for expansion.
- .6 Piping connections to equipment and terminal apparatus shall be supported independently and arranged to give easy access for maintenance.
- .7 Provide rubber grommets where refrigerant piping passes through a metal surface.
- .8 Install sleeves for piping penetrations of walls, ceilings, and floors.
- .9 Install fittings for changes in direction and branch connections.
- .10 Select system components with pressure rating equal to or greater than system operating pressure.
- .11 Install refrigerant piping in protective conduit where installed belowground.
- .12 Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical damage.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
 - .3 Provide inverted deep trap at top of risers.
 - .4 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m³/s at minimum load. Connect upstream of traps on large riser.
- .3 Safety-Relief-Valve Discharge Piping:
 - .1 Schedule 40, black-steel and wrought-steel fittings with welded joints. Construct joints according to AWS D10.12/D10.12M.
- .4 Diaphragm Packless Valves:
 - .1 Install diaphragm packless valves in suction and discharge lines of compressor.
 - .2 Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- .5 Service Valves:
 - .1 Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- .6 Check Valves:
 - .1 Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- .7 Strainers:
 - .1 Provide full size strainer ahead of each automatic valve. Where multiple expansion valves with integral strainers are used, install single main liquid line strainer.
 - .2 On steel piping systems, provide adequate strainer in suction line to remove scale and rust inherent in steel pipe.

- .3 Provide shut-off valve on each side of strainer to facilitate maintenance.
- .8 Filter Driers:
 - .1 Filter-driers may be used in systems instead of separate strainers and driers.
 - .2 Install with three valve bypass assembly to permit isolation for servicing.
- .9 Refrigerant Driers:
 - .1 Provide full flow permanent refrigerant drier in low temperature systems and systems utilizing hermetic compressors.
 - .2 Mount drier vertically in liquid line adjacent to receiver with three valve bypass assembly to permit isolation of drier for servicing.
- .10 Solenoid Valves:
 - .1 Provide solenoid valves in liquid line of system operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.
 - .2 Provide solenoid valves with manually operated stems.
- .11 Charging Valves:
 - .1 Provide refrigerant charging connections in liquid line between receiver shut-off valve and expansion valves.
- .12 Flexible Connectors:
 - .1 In general, install suction and hot piping connections to compressors with three directional changes for distance of minimum six pipe diameters before reaching point of support.
 - .2 Flexible connectors shall only be utilized at or near compressor where it is not physically possible to absorb vibration within piping configuration.

3.6 Pressure and Leak Testing

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.
- .3 Test procedure: build pressure up to 35 kPa 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.

3.7 Field Quality Control

- .1 Site Tests/Inspection:
 - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa 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 system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 hours.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 hours.
 - .4 Isolate pump from system, record vacuum, and time readings until stabilization of vacuum.
 - .5 Submit test results to Consultant.
- .7 All damaged or defective components shall be replaced with new (not reconditioned) components. A cracked or defective tube shall be replaced. If a defect of any description occurs in an insulated tube, the insulation shall be stripped to localize the leak. The amount of insulation so stripped shall be replaced with new - to be finished as specified
- .8 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.
- .9 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Provide necessary instruments, gauges and testing equipment required. Adjust controls, to obtain design requirements and manufacturer's ratings.
 - .3 Test and record cooling apparatus entering and leaving air temperatures, dry bulb, and wet bulb.
 - .4 Test and record voltage and running amperes and compare to motor nameplate data, and starter heater rating against design requirements.
 - .5 Ensure that refrigerant temperatures are accurate to within 0.5°C [0.9°F] of design requirements.
 - .6 In cooperation with controls contractor's representative, set and adjust automatic control system to achieve required sequence of operations.
 - .7 Bring equipment into operation, trial run and make up any loss of oil and refrigerant.
 - .8 Test reports to be submitted for review and inclusion in Maintenance Manuals.
- .10 Manufacturer's Field Services:
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its product[s] and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:

- .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
- .2 Twice during progress of Work at [25%] and [60%] complete.
- .3 Upon completion of the Work, after cleaning is carried out.
- .4 Obtain reports, within [3] days of review, and submit, immediately, to Consultant.

3.8 Demonstration

- .1 Instructions:
 - .1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

3.9 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

1. GENERAL

The following bid proposal includes all engineering specifications, installation, training, service and warranty for an Emergency Vehicle Exhaust Extraction System. Any deviations from this specification must be noted. Lowest priced equipment may not be approved if not considered to be equal and not in the best interest of the end user.

- 1.1. The function of the vehicle exhaust removal system will be to source capture 100% of the exhaust emissions directly at the tail pipe of the vehicle and exhaust those emissions to a specified area safely outside the building.
- 1.2. The exhaust system must not interfere with access to the vehicle, nor impede doorways/walkways/or exits that would endanger the welfare of fire personnel. **Drooping loops of hose or the hose assembly touching the floor will not be permitted.**
- 1.3. As safety to personnel is of the utmost importance, the system shall be so designed as not to whip or fly back into quarters upon disconnection. Vehicles shall be capable of exiting quarters at normal speed without causing damage to the system or taking any portion of the hose or nozzle assembly along with the exiting vehicle.
- 1.4. The fan shall automatically start prior to vehicle ignition.
- 1.5. The exhaust system must move with the vehicle in a forward or reverse direction of travel and **have an automatic release design** without any positive locking device or air bladder that clamps or binds to the tail pipe. **No system that uses the vehicles tailpipe, as a pulling disconnection force will be considered.**
- 1.6 The exhaust system shall utilize **a minimum of 15 cm (6") diameter hose**

2. SYSTEM OPERATION

The auto-disconnect exhaust system shall be a 24-volt **electromagnetic** release type that captures 100% of the exhaust emissions directly from the tail pipe and discharges those emissions to a specific location by means of an exhaust fan. Upon emergency dispatch of the vehicle, the exhaust fan shall automatically start prior to the engine being energized. The exhaust fan shall remain in the "on" position for as long as any engine is running. Upon vehicle exit, the hose assembly remains connected to the tail pipe and automatically disconnects at a specified distance outside the door by de-energizing the electromagnet. The nozzle and hose assembly shall smoothly separate from the vehicle and safely retract to the stored position ready to connect to the vehicle upon reentry. Upon disconnection, the hose assembly shall not be permitted to swing wide or touch the floor, possibly endangering personnel or apparatus. The hose shall remain at the door, ready for reconnection. Once the apparatus has left the building, the fan will automatically shut down after a preset time interval. Upon return, the fan is automatically activated prior to vehicle entry and the nozzle is connected to the tail pipe in a standing position. **Bending over to connect the exhaust system and expose the operator to harmful exhaust fumes is not permitted.** No positive locking device or moving parts shall be permitted to be connected to the tail pipe. After the vehicle has been turned off, the fan can continues to operate for a preset time interval, normally two minutes.

3. SCOPE OF WORK

- 3.1. A licensed and insured Contractor shall furnish and install a Source Capture Emergency Vehicle Exhaust Extraction System as designed and specified for the station(s).

- 3.2. The Contractor shall provide and install a centrifugal exhaust fan with capacity for all connected vehicles and sized for expansion if specified.
- 3.3. The Contractor shall provide and install an automatic fan start control console. The control console and all internal components shall be UL listed and manufactured in accordance with UL standard 508A and bear the UL label.
- 3.4. The Contractor shall provide and install all ductwork.
- 3.5. The Contractor shall be responsible for the delivery, safe storage, and handling of the products and protect them from weather elements.

4. SUBMITTALS AND CODES

The following submittals and code compliance shall be required:

- 4.1. Record building dimensions, note vehicle type and prepare shop drawings that include: equipment position, dimensions, sizes, weights, performance data, and also location and size of field connections.
- 4.2. Product Data: Provide manufacturer's literature and data sheets indicating rating capacities, dimensions, weights, accessories, and electrical requirements, wiring diagrams, location and size of field connections.
- 4.3. Provide fan curves with specified operating point clearly plotted.
- 4.4. Submit fan sound level data for fan specified.
- 4.5. Manufacturer's Installation, Operation and Maintenance Manual, which outlines the procedures required for system installation, start up, operation and shut down. The instructions shall include the manufacturer's name, telephone number, model number, service manual number, parts list, and brief description of all equipment and the basic operating features. The maintenance instructions shall list routine maintenance procedures, and troubleshooting guide.
- 4.6. Certifications: International Quality System Standard ISO 9001 and ISO 14001 Certified. UL Certification: UL listing, 508A Industrial Control Panel bulletin. Compliance with: NFPA 1500, 2003 International Mechanical Code, NIOSH CIB #50, OSHA 2001 American Conference of Governmental Industrial Hygienists (ACGIH) 2002 Proposed Regulations for Benzene and Diesel Exhaust Fumes. Federal Communications Commission approvals.
- 4.7. Compliance with all State and Local mechanical, electrical and building codes: Uniform Mechanical Code (UMC), American Society of Manufacturing Engineers (ASME), National Electric Code (NEC), Uniform Building Code (UBC), American Institute of Steel Construction (AISC), Sheet Metal and Air Conditioning Contractors National Association (SMACNA), American Society of Testing Materials (ASTM).

5. EQUIPMENT

- 5.1. Suction Rail Assembly

The Suction Rail shall be a polished aluminum extrusion that is formed in a configuration such that the extrusion serves not only as a suction duct, but also as the guide rail that the extraction

trolley travels in. The wall thickness of the aluminum extrusion shall be no less than 2.381 mm (0.09375"). The weight of the aluminum extrusion is 6.8 kg/m (4.6 lbs. per lineal foot). The area of the aluminum extrusion, in a cross-sectional view, shall have the minimum equivalent area of 189 cm² (0.2035 sq. ft.) with an overall length as specified and indicated on the drawings. Each open end of the suction rail shall be covered with an end cap that can also be used as a round duct outlet for 15 cm (6") diameter exhaust duct. As an alternate outlet, one or more rectangular-to-round transitions can be mounted on the topside of the suction rail after the cutout has been made per the manufacturer's specified size. A pair of EPDM rubber seals is installed at the bottom of the extrusion opening. The rubber seals have a Teflon strip on the inside surface which enables the trolley to travel smoothly and unhindered. The rubber seals close tightly during fan operation for an airtight seal, but open evenly around the trolley during trolley travel. The suction rail shall be supplied with internal rubber bumpers installed at both ends that serve as secondary stops to the trolley. The suction rail shall be supplied with suspension attachments that are specifically designed for fastening to the configuration of the suction rail. Spacing of the suspension attachments shall not exceed 16 feet center-to-center.

5.2. Extraction Trolley Assembly

The Extraction Trolley Assembly serves as the component in the Rail System that travels in the suction rail, carries and supports the vertical hose assembly, balancer, current collectors, shock absorber and trolley stop mechanism. The Extraction Trolley body shall be made of light weight composite with a low friction surface on each side to enable the trolley to travel smooth through the rubber seal. Also, on a formed bracket mounted to the composite body, shall be a Disconnection box, acting as a circuit breaker for the Electro Magnet. The rail design must be capable of handling up to 4 vehicles parked in tandem.

5.3. Balancer

Integrated to the Extraction Trolley Assembly is a Balancer. The adjustable tension Balancer shall retract the hose and nozzle away from the vehicle as it leaves the building and safely suspend the assembly off the floor in the storage position when not in use. The Balancer shall have a spring characteristics that ensure that the cord is wound onto the drum at a safe and constant speed.

5.4. Vertical Hose

The Upper Vertical Suction Hose shall be 16 cm (6.2") in diameter, and of suitable flexibility to have a compression ratio of minimum 8:1. The hose material shall be Trevira fabric covered with HYPALON (CSM, Chloro-sulfonated polyethylene). The hose shall be fire resistant according to DIN 4102 B1. The lower hose shall be designed to withstand a 260° C (500° F) engine temperature in conjunction with induced ambient air for cooling. The hose shall be capable of withstanding temperatures of 171° C (340° F) continuously, up to 188° C (370° F) on an intermittent usage basis. (NOTE: If a 'closed type sealed system' is being used, the temperature ratings must be 360° C [680° F] and 393° C [740° F] respectively.) The helix shall be external and made of aluminum. The helix shall have high flexibility and the fabric able to withstand oil, chemical, ozone and weather resistance.

5.5. Nozzle

The Nozzle shall be a minimum of 20cm (8") diameter and designed to capture 100% of the vehicle exhaust fumes generated at the vehicle tail pipe and is held in place by spring tension in conjunction with the electromagnet connection. The nozzle permits an ambient air mix in the air

stream to immediately reduce exhaust emission temperatures up to 50% at the point of capture. The reduced air stream temperatures prolong component life by not permitting thermal breakdown of materials. The Nozzle shall be designed so as not to cause or create back pressure on any vehicle engine, nor draw raw diesel- or gasoline fumes into the exhaust hose while connected to a non-operating vehicle, nor create the possibility of spinning a non-lubricated turbo which could result in bearing failure.

In a 'closed type sealed system', a pressurized container is created presenting an explosive potential when drawing raw fumes from a non-operating vehicle and all system electrical components must be of explosion proof design. **No closed system will be considered.** These conditions are non-existent with an ambient air mix nozzle design.

The operator never has to touch the Nozzle for connection, but can position the Nozzle over the tail pipe while the operator grips the hose handle and simultaneously connects the electromagnet to the anchor plate. Tension will be automatically applied to the Nozzle created by an internal leaf spring assembly, which holds the Nozzle firmly in place over the tail pipe. The positioning of the electromagnet on the vehicle, combined with the tension created at the Nozzle, shall not allow the Nozzle to come away from the tail pipe until the electromagnet is either automatically or manually de-energized. The Nozzle shall be constructed of both metal and rubber, with no internal movable parts related to the connection of the Nozzle to the tail pipe. The Nozzle Hose shall be a minimum of 16 cm (6.2") in diameter. The hose material shall be lightweight coated fiberglass with a smooth bore. The galvanized steel helix shall be completely rubber covered. The inlet diameter at the Nozzle is oversized to allow maximum airflow capacity for large engines and/or pump tests. The inlet boot of the Nozzle is to be made of EPDM rubber, and bonded to a sturdy 24 gauge steel conical reducer. The design of the nozzle shall allow for maximum flexibility to accept a variety of tail pipe configurations, which typically terminate at 90° to the side of the vehicle. **Tail pipe adapters are not permitted nor required. No positive locking devices or a concept of a positive locking device, pneumatics, internal or external air hoses, wires, airbags, valves or precautionary devices for pneumatic bursting pressure, magnetic (earth magnet type) shall be permitted or allowed.**

5.6. Electromagnetic Assembly

An electromagnet shall be used as the means of keeping the nozzle and hose assembly attached to the vehicle, whether at rest or as it moves to the point of exit. The electromagnet shall be 24 volts, DC with power supplied via an insulated conductor encapsulated within the helix of the upper hose. The electromagnet assembly shall consist of a nitro carburized electromagnet disc, a manual override switch, and an anchor plate. The electromagnet disc assembly shall be slightly recessed to serve as a guide for ease of connection to the anchor plate mounted on the vehicle and serve as the energized contact point. The formed collar shall be of a smooth and rounded configuration to prevent hooking or catching on external devices of the vehicle.

A manual override switch shall be easily accessible to disconnect the hose assembly while accessing storage compartments or performing vehicle maintenance. The manual override switch shall be conveniently mounted facing the operator. The purpose of the switch shall be to manually de-energize the electromagnet, allowing the hose and nozzle assembly to come away unrestrained from the vehicle when in the parked position within the building. The 24-volt UL switch shall be surrounded and mounted in a closed cell water resistant neoprene jacket.

The Anchor Plate shall be mounted on the vehicle to allow the operator, in an upright position, to connect the electromagnet. The Anchor Plate shall have an outer circular isolated holder made of hard resilient plastic. Recessed in the center of the holder shall be a finished, Nedox treated

steel disc to receive the electromagnet. The Anchor Plate shall be positioned on the vehicle in relation to the vertical and horizontal centerlines of the tail pipe outlet.

5.7. Disconnection Switch

Affixed to the Rail near the exit door, shall be a permanent magnet, which in conjunction with the disconnection box causes a 24-volt electromagnet to disconnect the hose assembly from the vehicle. The separation of the entire hose assembly from the vehicle is a one step process whereby no stress or strain is transferred from the vehicle to the exhaust hose or overhead brackets. Numerous mechanical functions to achieve nozzle separation such as valve activation, pneumatic deflation, and pulling forces to remove the nozzle from the tail pipe are not permitted. The disconnection switch shall be adjustable to create a nozzle release point at a specified distance as the vehicle exits the building. If a proper disconnect does not occur, the electromagnet has a built-in safety disconnection feature, which releases it with a 50-pound shear force. Then the hose and nozzle assembly remains intact. With other systems utilizing a mechanical or pneumatic direct connection to the tail pipe, a breakaway system is required to prevent the entire hose assembly from leaving the building with the vehicle.

5.8. End Stop

The Rail shall be equipped with an End Stop, one for each Trolley, which is designed to stop the travel of the entire hose, nozzle, and balancer assembly. The stopping action itself must be spring cushioned to prevent the assembly from coming to an abrupt and immediate halt at an exit speed of up to 24 km/h (15 mph). The End Stop consists of a coiled spring hydraulic oil damper, which is located in the front end of the each Suction unit.

5.9. Fan Auto-Start

The Fan Auto-Start serves to act as a remote control for fan start up to ensure the exhaust system is always running whenever an emergency vehicle is in operation. Upon dispatch, the exhaust fan shall automatically start and be running at full rpm prior to engine start up via a radio frequency transmitter mounted within the vehicle. The fan stays on as long as any vehicle is in operation. Upon vehicle exit or shut down, a variable timer then activates and the fan automatically turns off after a variable timed cycle. Upon vehicle return, the transmitter shall automatically activate the exhaust fan prior to the vehicle entering the building. The fan remains in operation until all vehicles are turned off and the timer then activates. The Control unit shall be FCC-approved and shall not interfere with radio communications garage doors or on board computers.

5.10. Centrifugal Fans

The fan shall be a direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller wheels shall be of a modified radial tip design, with top forward curve and airfoil thickness configuration characteristics. Impeller wheels shall be spark resistant and made of aluminum to prevent static electricity build up. The impeller shall be dynamically and static balanced, and of the non-overloading type to provide maximum efficiency while achieving quiet, vibrations free operation. The fan housing shall be manufactured from cast aluminum. The fan and motor assembly shall be mounted on a galvanized steel frame, which shall protect the motor, while also serving as a mounting platform for field installation.

For fans 5 HP and larger, centrifugal fans shall be fully enclosed, single-width, single-inlet steel construction as required or indicated. Impeller wheels shall have backward inclined or backward curved blades of the non-overloading type. The bearings shall be self-aligned ball bearing type

permanently sealed and lubricated. Fan shafts shall be steel and rotate in a non-sparking aluminum rubbing ring. Fans shall be accurately finished, and shall be provided with key and key seats for impeller hubs and fan pulleys. The fans shall be furnished with factory finish protective weather coating and a drain kit. The motor shall be totally enclosed fan cooled (TEFC). Motor starters shall be magnetic with general-purpose enclosures. The fan shall be structurally supported and provided with vibration isolators as specified to ensure quiet and smooth operation. The exhaust discharge outlet shall be in compliance with ACGIH recommendations and EPA requirements. Air intakes, windows, cascade systems, prevailing currents, communications equipment and building aesthetics will be considered in the final location of the fan. Exhaust filtration systems will be provided upon request and silencers will be provided when needed. All fans are tested in accordance with AMCA Standards in an AMCA approved test facility.

5.11. Air Flow Performance

Fan capacity shall be sized as such as to deliver a **650 cfm** (or as otherwise specified) at each hose drop to the vehicle being served. The exhaust system shall pull exhaust into the nozzle also inducing ambient air. The system shall be designed entirely for a negative pressure vacuum method of exhaust extraction. At no point in exhaust system will ducting be under positive pressure. Exhaust system hose drops shall be sized to maintain equal or larger cross sectional diameters than vehicle tailpipe. Exhaust systems, which do not size hose drops in accord with the vehicle engine capacity, as well as vehicle tailpipe diameter, shall not be accepted. The purpose of this portion of the specification is to insure that the exhaust system is designed to cool down exhaust as they are conveyed to the outside of fire station. This type of exhaust extraction keeps exhaust temperatures well below their designed temperature tolerances. This also prevents thermal break down of hose material thus adding years to system life. Exhaust systems that size exhaust drops without dilution ventilation and also down size the exhaust connection hose, unnecessarily put the vehicle engine warranty at risk. The delivered volume shall take into account all lengths of ductwork, elbows, and branches, shut off, wyes, etc., which accumulate the static pressure at the fan inlet. Manufacturer provided fans shall be performance guaranteed.

5.12. Duct Work

Ducts, unless otherwise specified or approved, shall be round and conform to the dimensions as shown on the drawings. Ducts shall be straight and smooth on the inside with airtight joints. Wherever ducts are used with crimped ends, the joint shall have crimp and bead arrangement. The bead shall provide a rigid stop for the mating open end to seat. Ducts shall be constructed of galvanized steel and sealed in accordance with standard SMACNA methods, for the system designed negative pressure in inches w.g. All duct joints to sealed and air tight.

Reducing fittings shall have a minimum of 2.54 cm (1") graduating increase in diameter per 20 cm (8") in length. Elbows up to 30 cm (12") in diameter shall have a centerline radius of not less than 1.5 times the diameter. Elbows beyond 30 cm (12") in diameter shall have a centerline radius of not less than 2.5 times the diameter. Branches shall enter the mains at a specified angle of not less than 30° with the centerline of the main duct in the direction of airflow, unless otherwise indicated or approved. Flexible connections to the main or branch duct shall be braced with approved metal straps or members.

5.13. Connections

Where duct of dissimilar metals are connected, or where sheet metal connections are made to fan inlet and outlet, only an approved fireproof flexible connection shall be used. The connection shall be installed and securely fastened by zinc coated steel clinch type draw bands for round ducts.

5.14. Framed Openings and Duct Sleeves

Duct sleeves shall be provided for all round ducts ≤ 38 cm (15") diameter that pass through floors, walls, ceilings, or roofs. Sleeves in non-load bearing walls shall be fabricated of 20-gauge steel conforming to ASTM A 525. Sleeves in load bearing walls shall be fabricated of standard weight galvanized steel pipe conforming to ASTM A 53. Collars for round ducts ≤ 38 cm (15") shall be fabricated from 20 gauge galvanized steel. Round ducts > 15 " in diameter passing through floors, walls, ceilings, or roofs shall be installed through framed openings. Structural steel members for framed openings shall conform to ASTM A 36. Framed openings shall provide a 2.54 cm (1") clearance between the duct and the opening. A closure collar of galvanized steel ≥ 10 cm (4") wide shall be provided on each side of the walls or floors where sleeves or framed openings are provided.

5.15. Stackhead

The exhaust discharge stack head will be a no loss type as recommended by ACGIH or as otherwise specified. The stack head design will protect against weather elements or introduction of debris.

5.16. Duct Test Holes

Test holes with covers shall be provided where indicated or directed, in the duct and plenum to insert Pitot tubes to take air measurements for balancing the air moving system if required.

6. INSTALLATION

6.1. Exhaust System

The exhaust removal system shall be installed as indicated and recommended by the manufacturer. Welding and brazing shall conform to ASME-17. Slip joints shall be sealed. Riser duct shall be supported to the structure as indicated on the drawings. Main duct shall be attached to building structural members.

6.2. Building Surface Penetrations

All penetrations shall be sealed. Sleeves or framed openings shall be utilized where duct penetrates building surfaces. The space between the sleeve or framed opening and the duct shall be packed with mineral wool or approved material. Closure collars shall be installed around the duct on both sides of the penetrated surface. Collars shall fit tight against the building surfaces and snug around the duct.

6.3. Guide Track

Installation height of Guide Track shall be between 3 m (10 ft.) to 4.6 m (16 ft.) range or as otherwise indicated on the drawings. The Guide Track shall be installed approximately 36 cm (14") from the side of the vehicle and ≥ 30 cm (12") away from the side edge of the exit door.

The Guide Track for the exhaust system shall include corrosion resistant brackets for ease of mounting to structural channel, trusses, or angle iron. Brackets shall be a minimum of 0.318 cm (0.125") thickness. Mounting bolts to be no less than 0.953 cm (0.375") diameter (structural grade 8) for connection to steel frame. Bolts required for masonry installation shall be 0.5" x 3.5" expansion bolts, or 0.375" x 4" sleeve anchors for wall mount masonry connection. Recommendation: Unistrut 1 5/8" or Angle Iron 2"x 2"x 3/16".

6.4. Tests

Each exhaust system and inlet shall be balanced to produce the indicated air quantities within 10 percent at the conditions shown. Any fans with bearings shall be lubricated, and the speed, direction and rotation of each fan shall be checked and verified as running correctly. The running current of each motor shall be checked and verified as correct. Upon completion and prior acceptance of the installation, the exhaust system shall be tested at the operating conditions to demonstrate satisfactory functional and operating efficiency. The Contractor shall provide all instruments, facilities, and labor required to properly conduct the tests.

7. TRAINING

The Contractor, or authorized approved personnel, shall provide training to the Owner (or appointed representative) in the daily use of and maintenance of the vehicle exhaust removal system installed and specified herein.

8. QUALITY ASSURANCE

All workmanship, manufacturing procedures, airflow design, and materials shall be tested and performance guaranteed.

9. EQUIPMENT WARRANTY

The Contractor shall guarantee all materials, equipment and workmanship for a period of one (1) year from date of final acceptance of the complete job, against original defects of material and workmanship, or excessive wear or deterioration.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 The variable capacity, heat pump heat recovery air conditioning system shall be a VRF (Variable Refrigerant Flow) zoning system manufactured by the scheduled manufacturer.
- .2 The heat recovery series system shall consist of an outdoor unit, BC (Branch Circuit) Controller (for two pipe type systems), multiple indoor units, and factory DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.
- .3 The non-heat recovery series system shall consist of an outdoor unit, multiple indoor units, and factory DDC (Direct Digital Controls). The system shall freely switch between heating or cooling mode. The sum of connected capacity of all indoor air handlers shall range from 50% to 130% of outdoor rated capacity.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 22 07 11 – Fire Stopping
- .4 Section 23 05 48 - Vibration and Seismic Control for Mechanical
- .5 Section 23 07 19 – HVAC Piping Insulation
- .6 Section 23 23 00 – Refrigerant Piping
- .7 Section 23 08 00 – Commissioning of Mechanical Systems

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 Applicable Building Code - Refer to Section 21 05 01
- .2 Air-Conditioning, Heating, & Refrigeration Institute (AHRI)
 - .1 AHRI 210/240- [2017], Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.
- .3 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 15- [2016], Safety Standard for Refrigeration Systems.
 - .2 ASHRAE Standard 52.2 - [2017], Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .3 ASHRAE Standard 62.1 - [2016], Ventilation for Acceptable Indoor Air Quality.
 - .4 ASHRAE Standard 90.1 - [2016], Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA B52 – 13, Mechanical Refrigeration Code.

- .2 CAN/CSA-C656-14, Performance Standard for Split System and Single-Package Air Conditioners and Heat Pumps.

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
- .2 Product Data: For each type of product.
 - .1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for mode control units.
 - .2 Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - .3 Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
 - .4 Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
 - .5 Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and mode control unit control.
 - .6 Include description of control software features.
 - .7 Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
 - .8 Include refrigerant type and data sheets showing compliance with requirements indicated.
 - .9 For system design software.
 - .10 Indicate location and type of service access.
- .3 Shop Drawings:
 - .1 Include plans, elevations, sections, and mounting details.
 - .2 Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - .3 Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - .4 Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
 - .5 Include diagrams for power, signal, and control wiring.
 - .6 Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - .7 Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
 - .8 Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and CSA B52.

- .9 Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.
- .4 Qualification Data:
 - .1 For Installer: Certificate from VRF system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 - .2 Retain copies of Installer certificates on-site and make available on request.
 - .3 For VRF installing contractor.
- .5 Closeout Submittals
 - .1 Operation and Maintenance Data: For VRF systems to include in emergency, operation, and maintenance manuals. Service and installation manuals must be readily available on the manufacturer's website without entering a username and password.
- 1.5 Maintenance**
 - .1 Extra materials
 - .1 Provide maintenance materials in accordance with Section 01 78 00 Closeout Submittals.
 - .2 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - .3 Filters: One set for each unit with replaceable filters.
- 1.6 Quality Assurance**
 - .1 Manufacturer Qualifications:
 - .1 Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
 - .2 Having full-time in-house employees for the following:
 - .1 Product research and development.
 - .2 Product and application engineering.
 - .3 Product manufacturing, testing, and quality control.
 - .4 Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
 - .5 Installing contractor training.
 - .2 Factory-Authorized Service Representative Qualifications:
 - .1 Authorized representative of, and trained by, VRF system manufacturer.
 - .2 Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
 - .3 Service and maintenance staff assigned to support Project during warranty period.
 - .4 Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.

- .3 Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF system manufacturer.
 - .1 Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 - .2 Installer certification shall be valid and current for duration of Project.
 - .3 The installing contractor shall have attended VRF system manufacturer's installation training prior to installing the system.
 - .4 Retain copies of Installer certificates on-site and make available on request.
 - .5 Each person assigned to Project shall have demonstrated past experience.
 - .1 Demonstrated past experience with products being installed for period within three consecutive years before time of bid.
 - .2 Demonstrated past experience on three projects of similar complexity, scope, and value.
 - .6 Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.
- .4 The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- .5 All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- .6 The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- .7 All units must meet or exceed the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
- .8 A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.7 Delivery, Storage, and Handling

- .1 Deliver and store products in a clean and dry place.
- .2 Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- .3 Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- .4 Protect products from weather, dirt, dust, water, construction debris, and physical damage.
- .5 Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
- .6 Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- .7 Replace installed products damaged during construction.

1.8 Warranty

- .1 The units shall be covered by the manufacturer's limited warranty for a period of one (1) year from date of installation.
- .2 If the systems are:
 - .1 Installed by a contractor that has successfully completed a factory service course, AND
 - .2 Verified with a completed commissioning report submitted to and approved by the manufacturer's service department, then the units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of installation.
- .3 In addition the compressor shall have a manufacturer's limited warranty for a period of minimum seven (7) years from date of installation.
- .4 If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.
- .5 This warranty shall not include labor.
- .6 All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.
- .7 The VRF system shall be installed by a contractor with extensive product install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 Heat Recovery Extended Heating Range Outdoor Unit

- .1 General:
 - .1 The heat recovery series of equipment shall consist of an outdoor unit, indoor units, and factory DDC (Direct Digital Controls). The extended heating range heat recovery outdoor unit shall be used specifically with compatible factory VRF components. The outdoor units shall be equipped with multiple circuit boards that interface to the factory controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped, wired and run tested at the factory.
 - .2 The model nomenclature and unit requirements are as scheduled on drawings. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.
 - .3 The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.
 - .4 Outdoor unit shall have a sound rating no higher than 58 dB (A) individually or 61 dB (A) twinned. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

- .5 Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated.
- .6 There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.
- .7 Outdoor unit shall be able to connect to up to 48 indoor units depending upon model.
- .8 The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
- .9 The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
- .10 The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-2625 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.
- .11 The outdoor unit shall have rated performance of heating operation at -13°F ambient temperatures and cooling mode down to 23°F ambient temperatures, without additional low ambient controls. The unit shall maintain 100% heat output at 0°F without a supplemental heat source or a second compressor to boost low ambient heating performance. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
- .12 The outdoor unit shall be capable of operating in cooling mode down to -4°F with optional manufacturer supplied low ambient kit.
- .13 Manufacturer supplied low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.
- .14 Manufacturer supplied low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- .15 Manufacturer supplied low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available when requested.
- .16 The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
- .17 The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
- .18 Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
- .2 Heat Interchanger circuit.
 - .1 The outdoor unit shall contain a heat interchanger circuit for sub-cooling liquid prior to entering the outdoor coil during the heating mode.
 - .2 The interchanger shall be of a copper tube within a tube construction.
 - .3 The interchanger circuit refrigerant flow shall be controlled by an electronic expansion valve.
- .3 Unit Cabinet:

- .1 The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
- .4 Fan:
 - .1 Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 - .2 All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 - .3 All fan motors shall be mounted for quiet operation.
 - .4 All fans shall be provided with a raised guard to prevent contact with moving parts.
 - .5 The outdoor unit shall have vertical discharge airflow.
- .5 Refrigerant
 - .1 R410A refrigerant shall be required for outdoor unit systems.
 - .2 Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- .6 Coil:
 - .1 The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - .2 The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 - .3 The coil shall be protected with an integral metal guard.
 - .4 Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 - .5 The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
- .7 Compressor:
 - .1 Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
 - .2 A crankcase heater(s) shall be factory mounted on the compressor(s).
 - .3 The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-5% of rated capacity, depending upon unit size.
 - .4 The compressor will be equipped with an internal thermal overload.
 - .5 The compressor shall be mounted to avoid the transmission of vibration.
 - .6 Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
- .8 Controls:
 - .1 The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system.

- .9 Electrical:
 - .1 The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.
 - .2 The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).
 - .3 The outdoor unit shall be controlled by integral microprocessors.
 - .4 The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.3 Branch Circuit (BC) Controllers

- .1 General
 - .1 The BC (Branch Circuit) Controllers are used for two pipe style VRF systems.
 - .2 The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.
 - .3 The BC (Branch Circuit) Controllers shall be specifically used with R410A systems. These units shall be equipped with a circuit board that interfaces to the factory controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
- .2 BC Unit Cabinet:
 - .1 The casing shall be fabricated of galvanized steel.
 - .2 Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
 - .3 The unit shall house two tube-in-tube heat exchangers.
- .3 Refrigerant
 - .1 R410A refrigerant shall be required.
- .4 Refrigerant valves:
 - .1 The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
 - .2 Each branch shall have multiple two-position valves to control refrigerant flow.
 - .3 Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
 - .4 Linear electronic expansion valves shall be used to control the variable refrigerant flow.
- .5 Integral Drain Pan:
 - .1 An integral drain pan and drain shall be provided.

- .6 Electrical:
 - .1 The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.
 - .2 The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz) or 207-253 (230/60Hz).
 - .3 The BC Controller shall be controlled by integral microprocessors.
 - .4 The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.4 Ceiling-Concealed Ducted Indoor Unit

- .1 General:
 - .1 Mandatory independent operation of all other indoor fan coils in case of a power failure or in case of electrical power interruption for any of the fan coils, is required.
 - .2 The indoor unit shall be a ceiling-concealed ducted coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The unit shall be used with the heat recovery outdoor unit and BC Controller or non-heat recovery outdoor unit. The indoor unit shall support individual control using factory DDC controllers.
- .2 Indoor Unit.
 - .1 The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- .3 Unit Cabinet:
 - .1 The unit shall be, ceiling-concealed, ducted.
 - .2 The cabinet panel shall have provisions for a field installed filtered outside air intake.
- .4 Fan:
 - .1 External static pressure settings from 0.14 to 0.60 in. WG.
 - .2 The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
 - .3 The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
 - .4 The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function.
 - .5 The indoor unit shall have a ducted air outlet system and ducted return air system.
- .5 Filter:
 - .1 All ceiling concealed ducted indoor units are to be supplied complete with return filter rack (rear or bottom placement).
 - .2 Include field supplied high-efficiency MERV-13 filter, for each ceiling concealed ducted indoor unit.
- .6 Coil:

- .1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
- .2 The tubing shall have inner grooves for high efficiency heat exchange.
- .3 All tube joints shall be brazed with phos-copper or silver alloy.
- .4 The coils shall be pressure tested at the factory.
- .5 A condensate pan and drain shall be provided under the coil.
- .6 The condensate shall be gravity drained from the fan coil.
- .7 Both refrigerant lines to the indoor units shall be insulated in accordance with the installation manual.
- .7 Electrical:
 - .1 The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
 - .2 The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- .8 Controls:
 - .1 This unit shall use controls provided by the factory to perform functions necessary to operate the system. Please refer to the controls section below for details on controllers and other control options.
 - .2 Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 - .3 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 - .4 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 - .5 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.5 Ceiling-Suspended Indoor Unit

- .1 General:
 - .1 The indoor unit shall be ceiling-suspended style and have a modulating linear expansion device. The indoor unit shall be used with the heat recovery outdoor unit and BC Controller(s) or the non-heat recovery outdoor unit. The indoor unit shall support individual control using factory DDC controllers.
- .2 Indoor Unit
 - .1 The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. The unit shall have an auto-swing function for the horizontal vane. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- .3 Unit Cabinet:
 - .1 The casing shall have a white finish.

- .4 Fan:
 - .1 The indoor unit fan shall be an assembly with two, three, or four Sirocco fan(s) direct driven by a single motor.
 - .2 The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - .3 The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High, and Auto fan function.
- .5 Filter:
 - .1 Return air shall be filtered by means of an easily removable, washable filter.
- .6 Coil:
 - .1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - .2 The tubing shall have inner grooves for high efficiency heat exchange.
 - .3 All tube joints shall be brazed with phos-copper or silver alloy.
 - .4 The coils shall be pressure tested at the factory.
 - .5 A condensate pan and drain shall be provided under the coil.
 - .6 Both refrigerant lines to the indoor units shall be insulated in accordance with the installation manual.
- .7 Electrical:
 - .1 The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
 - .2 The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- .8 Controls:
 - .1 This unit shall use controls provided by the factory to perform functions necessary to operate the system. Please refer to the controls section below for details on controllers and other control options.
 - .2 Units shall have the ability to control supplemental heat via a factory connector and a 12 VDC output.
 - .3 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 - .4 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 - .5 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.6 Controls

- .1 General:
 - .1 The factory controls network shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet®.
- .2 Electrical Characteristics
 - .1 General:

- .1 The controls network shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.
- .2 Wiring:
 - .1 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
 - .2 Control wiring for the smart remote controller shall be from the remote controller to the first associated indoor unit connection. The smart remote controller shall be assigned a network address.
 - .3 Control wiring for the simple and wireless remote controllers shall be from the remote controller (receiver) to the first associated indoor unit then to the remaining associated indoor units in a daisy chain configuration.
 - .4 Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
 - .5 The centralized controller shall be capable of being networked with other centralized controllers for centralized control.
- .3 Wiring type:
 - .1 Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire.
 - .2 Network wiring shall be CAT-5 with RJ-45 connection.
- .3 Controls Network
 - .1 The controls network consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The controls network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either BACnet® interfaces.
- .4 Controls Network Remote Controllers
 - .1 Smart Remote Controller

- .1 The smart remote controller shall be capable of controlling up to 16 indoor units (defined as 1 group). The smart remote controller shall be approximately 5.5" x 5" in size and white in color with an auto-timeout touch screen LCD display. The smart remote controller shall support a selection from multiple languages (English or French) for display information. The smart controller supports temperature display selection of Fahrenheit or Celsius. The smart remote controller shall control the following grouped operations: On/Off, Operation Mode (cool, heat, auto*, dry, fan and setback* (*heat recovery series Simultaneous Heating and Cooling only)), temperature set point, fan speed setting, and airflow direction setting. The smart remote controller shall support timer settings of on/off/temperature up to 8 times in a day in 5-minute increments. The smart remote controller shall support an Auto Off timer. The smart remote controller shall be able to limit the set temperature range from the smart remote controller, or via a PC through a factory centralized remote controller. Also, the temperature range can be set from a factory touch screen central controller. The room temperature shall be sensed at either the smart remote controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The smart remote controller shall display a four-digit error code in the event of system abnormality or error.
- .2 The smart remote controller shall only be used in same group with other smart remote controllers with a maximum of two smart remote controllers per group.
- .3 The smart remote controller shall require manual addressing using rotary dial switch to the communication bus. The smart remote controller shall connect using two-wire, stranded, non-polar control wire to the connection terminal on the indoor unit.

| Smart Remote Controller | | | |
|--------------------------------|--|------------------|----------------|
| Item | Description | Operation | Display |
| ON/OFF | Run and stop operation for a single group | Each Group | Each Group |
| Backlight | Turns on when screen is touched. Timeout duration is adjustable. | Each Group | Each Group |
| Operation Mode | Switches between Cool/Dry/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the heat recovery series only. | Each Group | Each Group |
| Temperature Setting | Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL, HEAT mode set points available depending on central controller, and connected mechanical equipment. | Each Group | Each Group |
| Fan Speed Setting | Available fan speed settings depending on indoor unit. | Each Group | Each Group |
| Air Flow Direction Setting | Air flow direction settings vary depending on the indoor unit model. | Each Group | Each Group |
| Room Temp and Humidity Display | Displays the room temperature and humidity on the home screen. Temperature and Humidity sensed can be calibrated using the sensor offset in 1 °F or 1% RH increments. | N/A | Each Group |
| Occupancy Sensor | Detects occupancy using an infrared motion sensor. Occupancy status is indicated on the remote controller and through the web interface depending on connected equipment. Sensitivity is adjustable. | N/A | Each Group |

| Smart Remote Controller | | | |
|------------------------------------|--|------------------|----------------|
| Item | Description | Operation | Display |
| Brightness Sensor | Detects brightness in the space and indicates brightness on the remote controller and through the web browser interface depending on connected equipment. Sensitivity is adjustable. | N/A | Each Group |
| Status Monitor | Displays the status of general equipment control points connected to the advanced HVAC controller | N/A | Each Group |
| Humidity Setting | Sets the relative humidity set point in 1% increments for any humidifier connected to the advanced HVAC controller | Each Group | Each Group |
| LED Indicator | Can be set to indicate the operation status by lighting and flashing with different colors and brightness or by turning off to signal operation mode, stopped unit, error, occupancy, or home screen button pushes. Color can be set to indicate the current mode selected or room temp range being sensed. *Available colors include blue, light blue, yellow, white, green, red, and lime. | Each Group | Each Group |
| Schedule | Set up to 8 operations per day, 7 days per week. Operations include time on/off, mode and room temperature set point. | Each Group | Each Group |
| Permit / Prohibit Local Operation | Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction, Reset filter). *1: Operation icon lights up on the remote controller for prohibited functions. | N/A | Each Group *1 |
| Energy-Save control during vacancy | When vacancy is detected by the occupancy sensor 5 control options are available for selection: Stop/Setback Mode/Set Temperature Offset/Low Fan Speed/Thermo-off Brightness sensor can be used in conjunction with the occupancy sensor to increase accuracy. | Each Group | Each Group |
| Error | When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed | N/A | Each Unit |
| Test Run | Operates air conditioner units in test run mode. | Each Group | Each Group |
| Set Temperature Range Limit | Set temperature range limit for auto, cool (drying), and heat modes. | Each Group | Each Group |
| Operation Lock Out Function | Locking of ON/OFF, Mode, Set Temp, Hold button and Air Direction. | Each Group | Each Group |
| Password | User and Service password protections are available | Each Group | N/A |
| Hold | Hold Prohibits the scheduled operation from being executed ON/OFF timer Auto-OFF timer Weekly timer Automatic return to the preset temperature * While an operation is prohibited by Hold function, the operation icon lights up. | Each Group | Each Group |

.1 Backlit Simple Remote Controller

- .1 The backlit simple remote controller shall be capable of controlling up to 16 indoor units (defined as 1 group). The backlit simple remote controller shall be compact in size, approximately 3" x 5" and have limited user functionality. The backlit simple remote controller supports temperature display selection of Fahrenheit or Celsius. The backlit simple remote controller shall allow the user to change on/off, mode (cool, heat, auto (heat recovery-series only), dry, setback (heat recovery-series only) and fan), temperature setting, and fan speed setting and airflow direction. The backlit simple remote controller shall be able to limit the set temperature range. The backlit simple remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the backlit simple remote controller or the indoor unit dependent on the indoor unit dipswitch setting. The backlit simple remote controller shall display a four-digit error code in the event of system abnormality/error.
- .2 The backlit simple remote controller shall only be used in same group with wireless remote controllers or with other backlit simple remote controllers, with up to two remote controllers per group.
- .3 The backlit simple remote controller shall require no addressing. The controller shall connect using two-wire, stranded, non-polar control wire to the connection terminal on the indoor unit. The simple remote controller shall require cross-over wiring for grouping across indoor units.

| Backlit Simple Remote Controller | | | |
|---|---|------------------|------------------|
| Item | Description | Operation | Display |
| ON/OFF | Run and stop operation for a single group | Each Group | Each Group |
| Operation Mode | Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the heat recovery series only. | Each Group | Each Group |
| Temperature Setting | Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL, HEAT mode set points available depending on central controller, and connected mechanical equipment. | Each Group | Each Group |
| Fan Speed Setting | Available fan speed settings depending on indoor unit. | Each Group | Each Group |
| Air Flow Direction Setting | Air flow direction settings vary depending on the indoor unit model. | Each Group | Each Group |
| Permit / Prohibit Local Operation | Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions. | N/A | Each Group *1 |
| Display Indoor Unit Intake Temp | Measures and displays the intake temperature of the indoor unit when the indoor unit is operating. | N/A | Each Group |
| Display Backlight | Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.) | N/A | Each Unit |
| Error | When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed | N/A | Each Unit |

| Backlit Simple Remote Controller | | | |
|---|---|------------------|------------------|
| Item | Description | Operation | Display |
| Test Run | Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display "test run"). | Each Group | Each Group *2 |
| Set Temperature Range Limit | Set temperature range limit for cooling, heating, or auto mode. | Each Group | Each Group |

.5 Controls Network System Integration

.1 The controls network shall be capable of supporting integration with Building Management Systems (BMS).

.2 BACnet® Interface

.1 The factory BACnet® interface shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.

.2 Basis of design: Mitsubishi model HD150.

.6 Power Supply

.1 The power supply shall supply 24VDC for the web enabled centralized controller and 30VDC voltage for the central control transmission.

.7 Expansion Controller

.1 In applications where the web enabled centralized controller is serving in excess of 50 remote indoor units/groups 1 expansion controller is required for each additional set of 50 remote indoor units/groups. Make reference to the associated installation manuals for further technical application details.

3. EXECUTION

3.1 Examination

.1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

.2 Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

.3 Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

.4 Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

.5 Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

- .6 Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- .7 Prepare written report, endorsed by installer, listing conditions detrimental to performance of the Work.
- .8 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Manufacturer's Authorization of an Installing Contractor:
 - .1 The Installing Contractor shall be fully trained and authorized by the VRF system manufacturer to install and commission the system.
 - .2 The Installing Contractor's training shall be sufficient to qualify the system for manufacturer's extended warranty.
- .2 General:
 - .1 Rig and install in full accordance with manufacturer's requirements, project drawings, and contract documents. Refer to the manufacturer's installation manual for full requirements.
 - .2 Install equipment with seismic-restraints. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 Vibration and Seismic Control for Mechanical.
- .3 Location:
 - .1 Locate indoor and outdoor units as indicated on drawings. Provide service clearance per manufacturer's installation manual. Adjust and level outdoor units on support structure.
 - .2 For climates that experience snowfall, mount the outdoor unit a minimum of 12" above the average snowfall line. In climates where this height requirement proves unfeasible, the outdoor units may be installed at the average snowfall line provided regular snow removal in the area surrounding the units keeps the snow line below the bottom of the units.
- .4 Installation of Indoor Units
 - .1 Install units to be level and plumb while providing a neat and finished appearance.
 - .2 Unless otherwise required by VRF system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch [10 mm].
 - .3 Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
 - .4 Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replace damaged areas after units are installed.
 - .5 In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
 - .6 In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
 - .7 Provide lateral bracing if needed to limit movement of suspended units to not more than required by manufacturer.
 - .8 For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

- .9 Install floor-mounted units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 Cast-in-Place Concrete.
- .10 Attachment: Install hardware for proper attachment to supported equipment.
- .11 Grouting: Place grout under equipment supports and make bearing surface smooth.
- .5 Installation of Outdoor Units
 - .1 Install units to be level and plumb while providing a neat and finished appearance.
 - .2 Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 Cast-in-Place Concrete.
 - .1 Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
 - .2 Grouting: Place grout under equipment supports and make bearing surface smooth.
- .6 Components / Piping:
 - .1 Refer to specification Section 23 23 00 Refrigerant Piping, supplemented herein.
 - .2 Installing contractor shall provide and install all accessories and piping for a fully operational system. Refer to manufacturer's installation manual for full instructions.
 - .3 Traps, filter driers, and sight glasses are NOT to be installed on the refrigerant piping or condensate lines unless directed otherwise by manufacturer's instructions.
 - .4 Standard ACR fittings rated for use with R410A are to be used for all connections. Proprietary manufacturer-specific appurtenances are not allowed.
 - .5 Refrigerant pipe shall be made of phosphorus deoxidized copper, and has two types.
 - .1 ACR "Annealed": Soft copper pipe, can be easily bent with human's hand.
 - .2 ACR "Drawn Temper": Hard copper pipe (Straight pipe), being stronger than Type-O pipe of the same radical thickness.
 - .6 The maximum operation pressure of R410A air conditioner is 4.30 MPa [623psi]. The refrigerant piping should ensure the safety under the maximum operation pressure. Refer to recommend piping specifications in the manufacturer's engineering manual. Pipes of radical thickness 0.7mm or less shall not be used.
 - .7 Flare connection should follow dimensions provided in manufacturer's installation manuals.
 - .8 Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
 - .9 Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - .10 Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.
 - .11 Install piping and tubing to permit valve servicing.
 - .12 Install piping and tubing free of sags.
 - .13 Install fittings for changes in direction and branch connections.
 - .14 Install piping and tubing to allow application of insulation.

- .15 Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
- .16 Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 23 00 Refrigerant Piping.
- .17 Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors.
- .7 Condensate Drain Piping
 - .1 Install a union in piping at each threaded unit connection.
 - .2 Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
 - .3 If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
 - .1 Details indicated on Drawings.
 - .2 Manufacturer's requirements.
 - .3 Governing codes.
 - .4 In the absence of requirements, comply with requirements of ASHRAE handbooks.
 - .4 Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
 - .5 Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.
 - .6 Gravity Drains: Slope piping from unit connection toward drain termination at a constant slope of not less than two percent.
 - .7 Pumped Drains: If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.
- .8 Insulation:
 - .1 Refrigerant lines, as well as any valves, shall be insulated as per specification Section 23 07 19 HVAC Piping Insulation.
- .9 Electrical:
 - .1 Installing contractor shall coordinate electrical requirements and connections for all power feeds with electrical contractor. Refer to Division 26 for additional information.
- .10 Third Party Controls:
 - .1 Installing contractor shall coordinate all BAS/BMS control requirements and connections with controls contractor.

3.3 Installation of System Control Cable

- .1 Comply with Section 25 09 01 Control Systems.

3.4 Fire Stopping

- .1 Comply with Section 07 84 00 Fire Stopping and Section 22 07 11 Fire Stopping.

3.5 Field Quality Control

- .1 Installing Contractor's Field Service: Representative of the installing contractor to witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
 - .1 Field service shall be performed by an authorized service representative of VRF system manufacturer or installing contractor who is experienced with the support of its products.
 - .2 Final Inspection before Startup:
 - .1 All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
 - .2 Installing contractor shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
 - .3 Inspection reports for indoor units shall include, but not be limited to, the following:
 - .1 Unit designation on Drawings.
 - .2 Manufacturer model number.
 - .3 Serial number.
 - .4 Network address, if applicable.
 - .5 Each equipment setting.
 - .6 Mounting, supports, and restraints properly installed.
 - .7 Proper service clearance provided.
 - .8 Wiring and power connections correct.
 - .9 Line-voltage reading(s) within acceptable range.
 - .10 Wiring and controls connections correct.
 - .11 Low-voltage reading(s) within an acceptable range.
 - .12 Controller type and model controlling unit.
 - .13 Controller location.
 - .14 Temperature settings and readings within an acceptable range.
 - .15 Humidity settings and readings within an acceptable range.
 - .16 Condensate removal acceptable.
 - .17 Fan settings and readings within an acceptable range.
 - .18 Unit airflow direction within an acceptable range.
 - .19 If applicable, fan external static pressure setting.
 - .20 Filter type and condition acceptable.
 - .21 Noise level within an acceptable range.
 - .22 Refrigerant piping properly connected and insulated.
 - .23 Condensate drain piping properly connected and insulated.

- .24 If applicable, ductwork properly connected.
- .25 If applicable, external interlocks properly connected.
- .26 Remarks.
- .4 Inspection reports for outdoor units shall include, but not be limited to, the following:
 - .1 Unit designation on Drawings.
 - .2 Manufacturer model number.
 - .3 Serial number.
 - .4 Network address, if applicable.
 - .5 Each equipment setting.
 - .6 Mounting, supports, and restraints properly installed.
 - .7 Proper service clearance provided.
 - .8 Wiring and power connections correct.
 - .9 Line-voltage reading(s) within acceptable range.
 - .10 Wiring and controls connections correct.
 - .11 Low-voltage reading(s) within an acceptable range.
 - .12 Condensate removal acceptable.
 - .13 Noise level within an acceptable range.
 - .14 Refrigerant piping properly connected and insulated.
 - .15 Condensate drain piping properly connected and insulated.
 - .16 Remarks.
- .5 Installer shall correct observed deficiencies found by the inspection.
- .6 Upon completing the on-site inspection, installing contractor shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
- .7 If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
- .8 Final report shall indicate the system(s) inspected are installed in accordance with manufacturer's requirements and are ready for startup.
- .2 Perform the following tests and inspections:
 - .1 Perform each visual and mechanical inspection. Certify compliance with test parameters.
 - .2 Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - .3 Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - .4 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 Startup Service

- .1 Engage a VRF system installing contractor's service representative to perform system(s) startup service.
 - .1 Service representative (or installing contractor) shall be trained and authorized by the VRF system manufacturer.
 - .2 Complete startup service of each separate system.
 - .3 Complete system startup service in accordance with manufacturer's written instructions.
- .2 Startup checks shall include, but not be limited to, the following:
 - .1 Check control communications of equipment and each operating component in system(s).
 - .2 Check each indoor unit's response to demand for cooling and heating.
 - .3 Check each indoor unit's response to changes in airflow settings.
 - .4 Check each indoor unit and outdoor unit for proper condensate removal.
 - .5 Check sound levels of each indoor and outdoor unit.
- .3 System Operation Report:
 - .1 After completion of startup service, installing contractor shall issue a report for each separate system.
 - .2 Report shall include complete documentation describing each startup check, the result, and any corrective action required.
 - .3 Installing contractor shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
 - .1 All available system operating parameters shall be included in the information submitted.
- .4 Witness:
 - .1 Invite Commissioning Agent to witness startup service procedures.
 - .2 Provide written notice not less than 10 business days before start of startup service.

3.7 Adjusting

- .1 Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.
- .2 Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- .3 Set field-adjustable switches and circuit-breaker trip ranges in accordance with VRF system manufacturer's written instructions, and as indicated.
- .4 Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 Protection

- .1 Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

- .2 Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
- .3 Protect equipment from electrical damage. Replace equipment suffering electrical damage.
- .4 Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.9 Maintenance Service

- .1 Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by service representative. Include two service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.10 Software Service Agreement

- .1 Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- .2 Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - .1 Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.11 Demonstration

- .1 Engage a VRF system installing contractor's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- .2 Instructor:
 - .1 Instructor shall be factory trained and certified by VRF system manufacturer with current training on the system(s), equipment, and controls that are installed.
 - .2 Instructor's credentials shall be submitted for review by Owner before scheduling training.
 - .3 Instructor(s) primary job responsibility shall be Owner training.
 - .4 Instructor(s) shall have not less than three years of training experience with VRF system manufacturer and past training experience on at least three projects of comparable size and complexity.
- .3 Schedule and Duration:
 - .1 Schedule training with Owner at least 20 business days before first training session.
 - .2 Training shall occur before Owner occupancy.
 - .3 Training shall be held at mutually agreed date and time during normal business hours.
 - .4 Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one -hour lunch period and 15 -minute break after every two hours of training.
 - .5 Perform not less than 16 total hours of training.

- .4 Location: Owner shall provide a suitable on-site location to host classroom training.
- .5 Training Attendees: Assume three people.
- .6 Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.
- .7 Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.
- .8 Training Materials: Provide training materials in electronic format to each attendee.
 - .1 Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - .2 Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- .9 Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

| Equivalent Nominal Diameter Of Pipes | | | | | |
|--------------------------------------|--------------|-----|--------------|-----|--------------|
| mm | inches (NPS) | mm | inches (NPS) | mm | inches (NPS) |
| 3 | 1/8 | 40 | 1-1/2 | 200 | 8 |
| 6 | 1/4 | 50 | 2 | 250 | 10 |
| 10 | 3/8 | 65 | 2-1/2 | 300 | 12 |
| 15 | 1/2 | 75 | 3 | 375 | 15 |
| 20 | 3/4 | 100 | 4 | 450 | 18 |
| 25 | 1 | 125 | 5 | 500 | 20 |
| 30 | 1-1/4 | 150 | 6 | 600 | 24 |

END OF SECTION

1. GENERAL

1.1 General

- .1 This Section specifies general conditions for Divisions 25 and is to be read, interpreted, and coordinated with all other sections of Division 25 and Section 21 05 01 – Common Work Results for Mechanical.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification Sections apply to work specified in this section.
- .3 Division 26 – Electrical.

1.3 References

- .1 Work, materials, and equipment shall comply with the most restrictive of local, provincial, and National authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
- .2 British Columbia Codes:
 - .1 British Columbia Electrical Code
 - .2 British Columbia Safety Authority

1.4 General Scope

- .1 'Provide' shall mean 'supply and install'.
- .2 Provide complete, fully tested, and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.
- .3 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.
- .4 Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.
- .5 Install equipment to provide: service access, maintain service clearances and for ease of maintenance.
- .6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner.

1.5 Coordination of Work

- .1 Products furnished but not installed under this division
 - .1 Division 22 – Plumbing
 - .1 Temperature Sensor Wells and Sockets
 - .2 Domestic water sub metering
 - .2 Division 23 – Heating, Ventilation and Air Conditioning

- .1 Control Valves
- .2 Flow Switches
- .3 Pressure and Temperature Sensor Wells and Sockets
- .4 Energy meters
- .5 Automatic Damper Actuators
- .6 Airflow Stations
- .7 Terminal Unit Controls
- .2 Products installed but not furnished under this division
 - .1 Division 22 – Plumbing
 - .1 Low-voltage wiring between 120VAC transformer and hands-free plumbing fixtures.
 - .2 Division 23 – Heating, Ventilation and Air Conditioning
 - .1 Refrigerant Leak Detection System
 - .3 Division 26 – Electrical
 - .1 Duct smoke detectors
- .3 Products not furnished or installed under but integrated with the work of this division
 - .1 Division 23 – Heating, Ventilation and Air Conditioning
 - .1 Variable frequency drives
 - .2 Division 26 – Electrical
 - .1 Fire alarm panel

1.6 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
- .2 Provide submittals on all hardware, software, and installation. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent. Provide drawings as files on optical disk (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data and the following:
 - .1 BAS Hardware:
 - .1 Manufacturer's description and technical data, performance curves, product specification sheets, and installation/maintenance instructions for:
 - .1 Control Panels
 - .2 Transducers/Transmitters
 - .3 Sensors (including accuracy data)
 - .4 Actuators

- .5 Valves
- .6 Relays/Switches
- .7 Operator Interface Equipment
- .8 Wiring
- .9 Other relevant items
- .2 Wiring diagrams and layouts for each control panel. Show all termination numbers.
- .3 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.
- .2 Central System Hardware and Software:
 - .1 Manufacturer's description and technical data, product specification sheets and installation/maintenance instructions for:
 - .1 Central Processing Unit
 - .2 Monitors, Printers
 - .3 Interface Equipment between CPU and Control Panels
 - .4 Operating System Software and/or Operator Interface Software
 - .5 Color Graphic Software and/or Third-Party Software
 - .6 Other relevant items
 - .2 Provide a schematic drawing of the central system. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - .3 Riser diagrams of wiring between central control unit and all control panels.
 - .4 A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.
- .3 Controlled Systems
 - .1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - .2 A schematic wiring diagram for each BAS. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the BAS schematic, it shall be labeled with the same name. All terminals shall be labeled.
 - .3 An instrumentation list for each controlled system. Each element of the BAS shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
 - .4 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.

- .1 Submitted sequence of operations shall not be direct copy of sequences in this section. Submittal shall include sufficient information to clarify items including but not limited to; deadbands, deadband intervals, ramp up/down times, loop types (PID/PI), comparisons for resets, Equipment starting stopping, capacity staging and control, delays, interlocks, loss of power results, interfacing with packaged equipment, etc.
- .5 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
- .4 Quantities of items submitted shall be reviewed but are the responsibility of the Division 25 Contractor.
- .5 Instrumentation and Data Point Summary Table. Contractor shall submit in table format with the following information for each instrument and data point. The table is to be reviewed and approved by the owner's representative prior to hardware and software installation and programming.
 - .1 Point name
 - .2 Point description: provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location
 - .3 Expected range (upper and lower limit)
 - .4 Instrumentation (as applicable): manufacturer, model number, range, and accuracy specification
 - .5 Type
 - .1 AI: analog input
 - .2 BI: binary input
 - .3 NAI: network analog input
 - .4 NBI: network binary input
 - .5 CP: Configuration Property
 - .6 P: Programmed (e.g., soft or virtual point in control sequence such as a PID input or output)
 - .7 C: Calculated value; a soft or virtual point. If calculated value, provide logic diagrams or code and any constants used in formula. If time-based integrated values are required, provide time periods: minutes, daily, weekly, monthly, and yearly. Also, indicate if it is a running average.
 - .6 Input resolution
 - .7 Graphic display resolution
 - .8 Data trend interval
- .3 Provide Record drawings and maintenance data in compliance with Division 01 - Closeout Submittals and the following:
 - .1 Submit project record documents upon completion of installation. Co-ordinate quantity to suit number of O&M manuals required. The documents shall be submitted for approval prior to final completion and shall include:
 - .2 Project Record Drawings. As-built versions of the submittal shop drawings provided as files on optical media and as 11" x 17" prints.

- .3 Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 25 08 00 Commissioning of Integrated Automation "BAS Demonstration" and "BAS Acceptance".
- .4 Operation and Maintenance (O & M) Manual.
- .5 As-built versions of submittal product data.
- .6 Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
- .7 Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
- .8 Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- .9 Graphic files, programs, and database on magnetic or optical media.
- .10 List of recommended spare parts with part numbers and suppliers.
- .11 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- .12 Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- .13 Licenses, guarantees, and warranty documents for equipment and systems.
- .14 Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

1.7 Acceptable Control System Primary Manufacturers

- .1 Refer to Section 23 05 01 for acceptable manufacturers list.
- .2 Quality Assurance
 - .1 Installer and Manufacturer Qualifications
 - .1 Installer shall have an established working relationship with BAS Manufacturer of not less than three years.
 - .2 Installer shall have successfully completed BAS control system training. Upon request, Installer shall present certification of completed training including hours of instruction and course outlines.

1.8 Identification

- .1 All components of the Building Management System shall be identification tagged.

1.9 Warranty

- .1 Warrant work as follows:
 - .1 Warrant labor and materials for specified BAS free from defects for a period of 12 months after final acceptance. BAS failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

- .2 Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
- .2 Special warranty on instrumentation:
 - .1 All instrumentation shall be covered by manufacturer's transferable [one-year] "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.10 Substantial & Total Performance

- .1 Comply with Section 21 05 01 Common Work Results for Mechanical – Substantial and Total Performance.
- .2 A certificate of Substantial Performance will not be granted unless the controls systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

1.11 Ownership of Proprietary Material

- .1 Project-specific software and documentation shall become Owner's property. This includes, but is not limited to graphics, record drawings, database, application programming code, and documentation.

2. PRODUCTS

2.1 Not used

3. EXECUTION

3.1 Examination

- .1 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Consultant for resolution before rough-in work is started.

3.2 Co-ordination

- .1 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- .2 Coordinate final graphics floor plans, room names and numbering with Architectural drawings including any changes made during construction. These graphics should be provided to the Engineers and the Owner for sign off before the graphics are completed.
- .3 The contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
- .4 Duct smoke detectors required for air handler shutdown are supplied under Division 26. The contractor shall interlock smoke detectors to air handlers for shutdown.
- .5 Smoke dampers required for duct smoke isolation are provided under Division 23 and actuators under Division 25. Division 25 shall interlock these dampers to the air handlers as described in the Sequences of Operation."

- .6 Fire/smoke dampers and actuators required for fire rated walls are provided under Division 23. Fire/smoke dampers powered by Div 26. Wiring for end-switch by Div 25.
- .7 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the BAS specified in this section. These controls shall be integrated into the system and coordinated by this Contractor as follows:
 - .1 Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - .2 The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 - .3 The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 - .4 The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.3 General Workmanship

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- .4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- .6 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial, and federal codes and ordinances as identified in Part 1 of this specification.
- .7 The scheduling of fans through existing or temporary time clocks or BAS shall be maintained throughout the BAS installation.
- .8 Modify existing starter control circuits, if necessary, to provide hand/off/auto control of each starter controlled. If new starters or starter control packages are required, these shall be included as part of this contract.

3.4 Training

- .1 Provide training sessions period for personnel designated by the Owner. The number of training sessions required should be agreed with the Engineers and Owner prior to commencement of training
- .2 Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be one day in length and must be coordinated with the building owner.
- .3 Train the designated staff of the owner to enable them to do the following:

- .1 Day-to-day Operators:
 - .1 Proficiently to operate the system
 - .2 Understand BAS architecture and configuration
 - .3 Understand BAS system components
 - .4 Understand system operation, including BAS control and optimizing routines (algorithms)
 - .5 Operate the workstation and peripherals
 - .6 Log on and off the system
 - .7 Access graphics, point reports, and logs
 - .8 Adjust and change system set points, time schedules, and holiday schedules
 - .9 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - .10 Understand system drawings and Operation and Maintenance manual
 - .11 Understand the job layout and location of control components
 - .12 Access data from BAS controllers and ASCs
 - .13 Operate portable operator's terminals
- .2 Advanced Operators:
 - .1 Make and change graphics on the workstation
 - .2 Create, delete, and modify alarms, including annunciation and routing of these
 - .3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - .4 Create, delete, and modify reports
 - .5 Add, remove, and modify system's physical points
 - .6 Perform BAS field checkout procedures
 - .7 Perform BAS unit operation and maintenance procedures
 - .8 Perform workstation and peripheral operation and maintenance procedures
 - .9 Perform BAS diagnostic procedures
 - .10 Maintain, calibrate, troubleshoot hardware
 - .11 Adjust, calibrate, and replace system components
- .3 System Managers/Administrators:
 - .1 Maintain software and prepare backups
 - .2 Interface with job-specific, third-party operator software
 - .3 Add new users and understand password security procedures
- .4 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.
- .5 Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.
- .6 The instructor(s) shall be factory-trained instructors experienced in presenting this material.

END OF SECTION