

# MECHANICAL SPECIFICATIONS

## DENISON DAYCARE CENTRE

900 MULOCK DRIVE, NEWMARKET, ONTARIO

Project #: 19146  
Revision 01  
November 4, 2020



**RDZ ENGINEERS LIMITED**  
17A - 30 Pennsylvania Avenue  
Vaughan, Ontario  
L4K 4A5



November 4, 2020	1	ISSUED FOR PERMIT REVISION	VK	MDZ
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<b>Date</b>	<b>Revision</b>	<b>Description</b>	<b>Prep. By</b>	<b>Check By</b>

**DIVISION 20**

**MECHANICAL COMMON WORK RESULTS**

Section 20 05 01	Supplementary Mechanical Bid Form
Section 20 05 05	Mechanical Work General Instructions
Section 20 05 10	Basic Mechanical Materials and Methods
Section 20 05 20	Mechanical Vibration Control
Section 20 05 25	Mechanical Insulation
Section 20 05 40	Mechanical Work Commissioning
Section 20 05 50	Testing, Adjusting and Balancing
Section 20 05 55	Firestopping and Smoke Seal Systems

**DIVISION 21**

**FIRE SUPPRESSION**

Section 21 13 00	Fire Protection Sprinkler System
Section 21 20 05	Fire Extinguishers

**DIVISION 22**

**PLUMBING**

Section 22 11 00	Domestic Water Piping and Specialties
Section 22 13 00	Drainage and Vent Piping and Specialties
Section 22 30 00	Plumbing Equipment
Section 22 42 00	Plumbing Fixtures and Fittings

**DIVISION 23**

**HEATING, VENTILATING AND AIR CONDITIONING**

Section 23 11 23	Natural Gas Piping System
Section 23 20 00	HVAC Piping and Pumps
Section 23 23 00	Refrigerant Piping, Valves and Accessories
Section 23 25 00	HVAC Water Treatment
Section 23 30 00	HVAC Air Distribution
Section 23 34 00	HVAC Fans
Section 23 41 00	Air Filters and Accessories
Section 23 51 23	Flue Gas Vents
Section 23 52 04	Hot Water Boilers
Section 23 74 23	Packaged Rooftop Units
Section 23 81 26	Split System Air Conditioning Equipment
Section 23 82 39	Motorized Heaters

**DIVISION 25**

**INTEGRATED AUTOMATION**

Section 25 05 05

Automatic Control Systems

**END OF SECTION**

PROJECT NAME: Denison Daycare Centre

RDZ PROJECT NUMBER: 19146

The following Supplementary Mechanical Bid Form is submitted by:

.....  
(Bidding Company)

.....  
(Street Address or P. O. Box No.)

.....  
(City, Province and Postal Code)

Dated ..... and which is an integral part of the Bid Form.

In accordance with Instructions to Bidders, we provide the Supplementary Mechanical Bid Form. We understand that the information provided shall be considered an integral part of the Bid Form and shall be completed in full.

Where instructions are not provided, submit Supplementary Mechanical Bid Form within 24 hours of Bid closing, via e-mail addressed to:

RDZ Engineers Ltd.

Attention: Michael Di Zio

e-mail: [michael@rdzeng.ca](mailto:michael@rdzeng.ca)

copied to e-mail: [vivien@rdzeng.ca](mailto:vivien@rdzeng.ca)

Supplementary Bid Form Signature:

.....  
(Signature of Authorized Representative)

.....  
(Print Name)

.....  
(Title)

### LIST OF PROPOSED MANUFACTURERS

We submit, herein, typed, or neatly printed, the names of the manufacturers upon whose products our Bid Price is based. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance, and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance, and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non-base specified manufacturers with respect to their equivalency shall be at Consultant's discretion.

PRODUCT/WORK (SECTION NAME)	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER/COMPANY
Mechanical Vibration Control Components	
Dry Pipe Zone Air Compressor (tank mounted)	
Domestic Hot Water Storage Heater	
Horizontal In-Line Circulation Pumps	
Recirculating Pumps	
Air Separator	
Expansion Tank	
Grilles and Diffusers	
Hot Water Boiler	
Split System Air Conditioning Equipment	
Packaged Rooftop Units	
Centrifugal Inline Fan	
Toilet Exhaust Fans	
Fin-Tube Type Direction Radiation Unit	
Cabinet Unit Heaters	

END OF DOCUMENT

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Division 00 and Division 01 apply to and are a part of this Section.

### **1.02 APPLICATION**

- .1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence.
- .2 Be responsible for advising product vendors of requirements of this Section.

### **1.03 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 "barrier-free" – means when applied to a building and its facilities, that building and its facilities can be approached, entered and used by persons with physical or sensory disabilities in accordance with requirements of local governing building code.
- .9 "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.
- .10 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and regulations that apply to and govern work and to which work must adhere.

- .11 "OSHA" and "OHSA" – 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.
- .12 "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.
- .13 "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
- .14 "Consultant" – means person, firm or 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.
- .15 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.
- .16 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.

#### 1.04 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Specification is arranged in accordance with CSI/CSC 50 Division Sections MasterFormat.
- .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

- .7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.
- .12 When scale and date of Drawings are the same, or when discrepancy exists within Specification, include most costly arrangement to take precedence.
- .13 In case of discrepancies or conflicts between Drawings and Specification, documents will govern in following order:
  - .1 Specification;
  - .2 Drawings of larger scale;
  - .3 Drawings of smaller scale;
  - .4 Drawings of later date when scale of Drawings is same.

#### **1.05 METRIC AND IMPERIAL MEASUREMENTS**

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

#### **1.06 WORK STANDARDS**



- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.
- .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
  - .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
  - .2 Air Movement and Control Association (AMCA);
  - .3 American Iron and Steel Institute (AISI);
  - .4 American National Standards Institute (ANSI);
  - .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
  - .6 American Society of Mechanical Engineers (ASME);
  - .7 American Society of Testing and Materials (ASTM);
  - .8 American Water Works Association (AWWA);
  - .9 Associated Air Balance Council (AABC);
  - .10 Building Industry Consulting Services, International (BICSI);
  - .11 Canadian Gas Association (CGA);
  - .12 Canadian General Standards Board (CGSB);
  - .13 Canadian Standards Association (CSA);
  - .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
  - .15 Electrical Safety Authority (ESA);
  - .16 Electronic Industries Association (EIA);
  - .17 Factory Mutual Systems (FM);
  - .18 Illuminating Engineering Society (IES);
  - .19 Institute of Electrical and Electronic Engineers (IEEE);
  - .20 International Standards Organization (ISO);

- .21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
  - .22 National Building Code of Canada (NBC);
  - .23 National Electrical Manufacturers Association (NEMA);
  - .24 National Environmental Balancing Bureau (NEBB);
  - .25 National Fire Protection Association (NFPA);
  - .26 National Standards of Canada;
  - .27 NSF International;
  - .28 Occupational Health and Safety Act (OHSA);
  - .29 Ontario Building Code (OBC);
  - .30 Ontario Electrical Safety Code (OESC);
  - .31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
  - .32 Technical Standards and Safety Authority (TSSA);
  - .33 Thermal Insulation Association of Canada (TIAC);
  - .34 Underwriters' Laboratories of Canada (ULC);
  - .35 Workplace Hazardous Materials Information System (WHMIS);
  - .36 Material Safety Data Sheets by product manufacturers;
  - .37 local utility inspection permits;
  - .38 Codes, standards, and regulations of local governing authorities having jurisdiction;
  - .39 additional codes and standards listed in Trade Sections;
  - .40 Owner's standards.
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
  - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
  - .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions. Notify Consultant in writing of conflicts between Contract Documents and manufacturer's instructions.

- .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
- .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with Consultant at any time.
- .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
- .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
- .11 Properly protect equipment and materials on site from damage and defacement due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
- .12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products are to bear a CRN number.
- .13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

#### **1.07 PERMITS, CERTIFICATES, APPROVALS AND FEES**

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.
- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

#### **1.08 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.

#### **1.09 WORKPLACE SAFETY**

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.

#### **1.10 PLANNING AND LAYOUT OF WORK**

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
  - .1 piping requiring uniform pitch;
  - .2 piping 100 mm (4") dia. and larger;

- .3 large ducts (main runs);
  - .4 cable tray and bus duct;
  - .5 conduit 100 mm (4") dia. and larger;
  - .6 piping less than 100 mm (4") dia.;
  - .7 smaller branch ductwork;
  - .8 conduit less than 100 mm (4") dia..
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

#### 1.11 PHASING

- .1 Project partial occupancy permits to be required throughout project. Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems.

#### 1.12 COORDINATION OF WORK

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
  - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
  - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
  - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
  - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

#### 1.13 PRODUCTS

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.

- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
- .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
- .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
- .6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
- .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.

- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by Consultant.
- .9 Indicate in Supplementary Mechanical Bid Form, names of manufacturers for proposed products to be supplied, and which were based specified or scheduled with a manufacturer's name. Names of proposed manufacturers on list must be one of names stated as acceptable for particular products, unless prior approval from Owner has been given for use of products by other manufacturers. Submit to Consultant for review as directed.
- .10 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
- .11 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .12 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.
- .13 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with Consultant, and costs for review, to be borne by Contractor.
- .14 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

#### **1.14 SHOP DRAWINGS**



- .1 At start-up meeting, review with Consultant products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
- .2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Coordinate exact requirements with Consultant.
- .3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
  - .1 product literature cuts;
  - .2 equipment data sheets;
  - .3 equipment dimension drawings;
  - .4 system block diagrams;
  - .5 sequence of operation;
  - .6 connection wiring schematic diagrams;
  - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
  - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
  - .2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:

"THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.

#### **1.15 ENGINEERED SUBMITTALS**

- .1 Submittals for items required to be sealed by a professional engineer (engineered) are to be duly prepared, sealed, and signed under direct control and supervision of a qualified professional engineer licensed in jurisdiction of the work. Professional engineer is to conform to requirements specified in this Section in article entitled Requirements for Contractor Retained Engineers.
- .2 Engineered submittals are to include, but not be limited to, following:
  - .1 complete CAD layout drawings indicating equipment, piping schematic, pipe routing and sizing, zones, devices, wiring schematics, and any other pertinent data;
  - .2 listing of design data used to determine system layout and sizing;
  - .3 complete copies of design calculations and listing of design data used in preparing calculations;
  - .4 list detailing standards, codes, regulations, etc. adhered to when designing system;
  - .5 items as noted in other Sections of the Specification.
- .3 Professional engineer responsible for engineered submittals is to perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work, and submit a field review report after each visit. Submit field review reports to Consultant and authorities having jurisdiction as required.

- .4 Field reviews are to be at intervals as necessary and appropriate to progress of work described by engineered submittal to allow engineer to be familiar with progress and quality of such work and to determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
- .5 Upon completion of work as described by engineered submittal, professional engineer responsible for preparation of engineered submittal and for performing periodic field reviews is to prepare and submit to Consultant and, if applicable, authorities having jurisdiction, a letter certifying that work has been supplied and installed in accordance with requirements of Contract Documents, authorities having jurisdiction and engineered submittal.

#### **1.16 EQUIPMENT LOADS**

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with Consultant prior to construction.

#### **1.17 OPENINGS**

- .1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval from Owner and reviewed with Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless otherwise directed by Owner and reviewed with Consultant, do not leave any openings unprotected and unfinished overnight.

#### **1.18 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 and reviewed with Consultant.
- .2 Use scaffolds in such a manner as to interfere as little as possible with work of other trades.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with Consultant. No supports, clips, brackets or similar devices are to be welded, bolted or otherwise affixed to any finished member or surface without approval from Owner and review with Consultant.

- .4 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.

#### 1.19 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 detailing 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 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:
  - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
  - .2 material costs are not to exceed those published in local estimating price guides;
  - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
  - .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
  - .5 costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
  - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
  - .7 costs for rental tools and/or equipment are not to exceed local rental costs;
  - .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
  - .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.

- .6 Make requests for changes or revisions to work in writing to Consultant and, if accepted by Owner, Notice of Change to be issued.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

#### **1.20 PROGRESS PAYMENT 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.

#### **1.21 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.

#### **1.22 PRELIMINARY TESTING**

- .1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

#### **1.23 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION**

- .1 Permanent mechanical systems in building may be used for temporary heating or cooling during construction subject to 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 building has been closed in and areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes;
  - .4 there is no possibility of damage from any cause;
  - .5 supply ventilation systems are protected by 60% filters, which are to be inspected daily, and changed every 2 weeks, or more frequently as required;
  - .6 return air systems have approved construction filters over openings, inlets, and outlets;
  - .7 systems are operated in accordance with manufacturer's recommendations or instructions, and are monitored on a regular and frequent basis;
  - .8 warranties are not affected in any way;
  - .9 regular preventive and other manufacturer's recommended maintenance routines are performed;
  - .10 before application for Certificate of Substantial Performance, each entire system is to be refurbished, cleaned internally and externally, restored to "as-new" condition, and filters in air systems replaced;
  - .11 energy costs are to be paid by Contractor.
- .2 Confirm with Consultant what equipment can be used during construction.
- .3 Any system or piece of equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
- .4 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.
- .5 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.

#### **1.24 TEMPORARY SERVICES**

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

#### **1.25 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE**

- .1 Maintain equipment in accordance with manufacturer's instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

#### **1.26 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.

#### **1.27 RECORD AS-BUILT DRAWINGS**

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant, at expense of \$25.00 CDN plus HST, per drawing, up to first 10 drawings, and \$5.00 CDN plus HST, per any additional drawings thereafter. Drawings may also to be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
  - .1 dimensioned location of inaccessible concealed work;
  - .2 locations of control devices with identification for each;

- .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
  - .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
  - .5 location of piping system air vents;
  - .6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
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- .3 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.
  - .4 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.
  - .5 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.
  - .6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.
  - .7 Retain and pay for services of a land surveyor registered in Place of the Work to measure, verify, and record size, location, invert elevation and pitch of buried piping services, and, when complete, to produce a signed and sealed AutoCAD disc (of release version reviewed with Consultant) of survey work which is to be submitted to Consultant. Transfer survey work to as-built drawings.

## 1.28 OPERATING AND MAINTENANCE MANUALS

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply minimum 3, project specific, indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Review exact quantity of manuals with Consultant. 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;
- .6 operating data as follows:
  - .1 pressure test reports, and certificates issued by governing authorities;
  - .2 description of each system and its controls;
  - .3 control schematics for equipment/systems including building environmental controls;
  - .4 wiring and connection diagrams;
  - .5 if applicable, BAS architecture and all required operating data;
  - .6 description of operation of each system at various loads together with reset schedules and seasonal variances;
  - .7 operation instruction for each system and each component;
  - .8 description of actions to be taken in event of emergencies and/or equipment failure;
  - .9 valve tag schedule, and flow diagrams to indicate valve locations.
- .7 maintenance data as follows:
  - .1 operation and trouble-shooting instructions for each item of equipment and each system;
  - .2 schedules of tasks, frequency, tools required, and estimated task time;
  - .3 recommended maintenance practices and precautions including warnings of any maintenance practice that will damage or disfigure equipment/systems;
  - .4 complete parts lists with numbers.
- .8 performance data as follows:
  - .1 equipment and system start-up data sheets;
  - .2 equipment performance verification test results, and final commissioning report;
  - .3 final testing, adjusting and balancing reports.
- .9 copies of warranties;

- .10 items requested specifically in Section Articles.
- .2 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.
- .3 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
- .4 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.

### 1.29 COMMISSIONING

- .1 An independent Commissioning Agent is to be retained by Contractor to perform equipment and system commissioning work as specified in Division 01, and in Section entitled Mechanical Work Commissioning. Where commissioning specifications are included as part of Division 01, requirements of Section entitled Mechanical Work Commissioning are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, more stringent requirement will apply unless otherwise directed by Consultant.

### 1.30 WARRANTY

- .1 Unless otherwise specified in Divisions 00 and 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to Consultant.
- .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
- .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:
  - .1 once during 1<sup>st</sup> month of building operation;
  - .2 once during 3<sup>rd</sup> month of building operation;

- .3 once between 4<sup>th</sup> and 10<sup>th</sup> month in a season opposite to 1<sup>st</sup> and 3<sup>rd</sup> month visits.

### 1.31 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
  - .1 Operating and Maintenance Manuals;
  - .2 as-built record drawings and associated data;
  - .3 extended warranties for equipment as specified;
  - .4 operating test certificates, i.e. Sprinkler Test Certificate;
  - .5 final commissioning report and TAB report;
  - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
  - .7 other data or products specified.

### 1.32 INSTRUCTIONS 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 (for up to 6 people each session), 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 Consultant 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.
- .8 Submit to Consultant, copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

### 1.33 FINAL INSPECTION

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
  - .1 deficiencies noted during job inspections have been completed;
  - .2 field quality control procedures have been completed;
  - .3 systems have been tested and verified, balanced and adjusted, and are ready for operation;
  - .4 maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted by Owner;
  - .5 tags and nameplates are in place and equipment identifications have been completed;
  - .6 clean-up is complete;
  - .7 spare parts and replacement parts specified have been provided and acknowledged by Consultant;
  - .8 as-built and record drawings have been completed and submitted to and reviewed with Consultant and accepted by Owner;
  - .9 Owner's staff has been instructed in operation and maintenance of systems;

.10 commissioning procedures have been completed.

**2 PRODUCTS**

NOT USED

**3 EXECUTION**

NOT USED

**END OF SECTION**

1. General
  - 1.1 APPLICATION
    - .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
  - 1.2 SUBMITTALS
    - .1 Submit shop drawings for all products specified in Part 2.
    - .2 Submit the following to the Consultant for review:
      - .1 a sample of each proposed type of access door, as well as a copy of architectural reflected ceiling plan drawings showing proposed ceiling access door locations;
      - .2 location drawings for all required sleeves and formed openings in poured concrete or precast concrete construction;
      - .3 a list of equipment identification nameplates indicating proposed wording and sizes;
      - .4 a list of pipe and duct identification colour coding and wording;
      - .5 a proposed valve tag chart and a list of proposed valve tag numbering and identification wording;
      - .6 samples of materials and any other items as specified in succeeding Sections of this Division of the Specification.
    - .3 Submit a spare belt set, tagged and identified, for each belt driven piece of equipment.
    - .4 Submit an affidavit stating that lead free solder was used for all soldered joints in copper potable water, drainage and vent piping.
2. Products
  - 2.1 PIPE SLEEVES
    - .1 Minimum No. 24 USS gauge (0.635 mm thick) galvanized steel with an integral flange to secure the sleeve to formwork construction.
    - .2 Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
    - .3 Schedule 40 mild galvanized steel pipe.
  - 2.2 FIRESTOPPING AND SMOKE SEAL MATERIALS
    - .1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Section entitled Firestopping and Smoke Seal Systems and work is to be done as part of mechanical work.
  - 2.3 PIPE ESCUTCHEON PLATES
    - .1 One-piece chrome plated black steel or stainless steel plates, sized to cover pipe sleeves or wall or slab openings and to fit tightly around the pipe or pipe insulation.
  - 2.4 CAST IRON PIPE, FITTINGS AND JOINTS
    - .1 Class 4000 cast iron pipe and fittings to CSA B70 and CGSB 77-GP-2a.

- .2 Centrifugally cast ductile iron to ANSI/AWWA C151/A21.51 complete with a cement mortar lining to ANSI/AWWA C104/A21.4 and a protective polyethylene exterior coating, standard cement lined cast iron mechanical joint fittings to ANSI/AWWA C110/A21.10 painted as for pipe, and rubber gasket joints to ANSI/AWWA C111/A21.11 with electric conductivity strips to bridge joints.

## 2.5 COPPER PIPE, FITTINGS AND JOINTS

- .1 DWV grade hard temper copper to CSA H7 and ASTM B306 "Copper Drainage Water Tube (DWV)", with forged copper solder type drainage fittings and 95% tin/5% Antimony solder joints.
- .2 Type "K" and "L", hard drawn seamless copper to CSA H7.6 and certified to ASTM B88 "Specification for Seamless Copper Water Tube", with forged copper solder type fittings to suit the pipe, and soldered joints, Englehard Corp. "SILVABRITE 100" or equal 4% silver/96% tin for cold water pipe, 95% tin/5% Antimony or for other pipe.
- .3 Type "L", seamless soft copper to ASTM B77, in continuous lengths of proper size with no joints wherever possible, but with flared tube fitting type joints where absolutely essential.
- .4 Type ACR, hard drawn seamless copper tubing to ASTM B280 "Standard For Seamless Copper Tube For Air Conditioning And Refrigeration Field Service", factory cleaned in accordance with ASTM B280, pressurized with nitrogen and supplied with capped ends, and complete with factory washed and capped wrought copper soldering fittings, and solder joints made with high melting point silver brazing alloy conforming to AWS Classification BCuP-5.

## 2.6 BLACK STEEL PIPE, FITTINGS AND JOINTS

- .1 Mild black carbon steel, Grade A, ASTM A53, continuous weld fabricated for pipe with screwed joints, ASTM A53 electric resistance weld fabricated, mill or site bevelled for pipe with welded joints.
- .2 Pipe for fire protection work shall be mild black carbon steel, Grade A ASTM A-795, continuous weld fabricated for pipe with screwed joints, ASTM A-795 electric resistance weld fabricated, mill or site bevelled for pipe with welded joints.
- .3 Threaded fittings shall be Class 125 (standard) or Class 250 (extra heavy) cast iron threaded fittings to ANSI/ASME B16.4.
- .4 Welding fittings shall be factory made, seamless carbon steel, bevelled, butt welding fittings to ASTM A234, Grade WPB, with a wall thickness to match the pipe wall thickness. All elbows shall be long radius pattern except where space conditions do not permit.

## 2.7 GROOVED END BLACK STEEL PIPE, FITTINGS AND JOINTS

- .1 Mild black steel pipe to ASTM A53, with factory or site grooved ends square cut or rolled in accordance with Victaulic Co. of Canada Ltd. Specification TS215/83 and to requirements of CSA B242.
- .2 Pipe for fire protection work shall be mild black steel pipe to ASTM A-795, with factory or site grooved ends square cut or rolled in accordance with Victaulic Co. of Canada Ltd. specification TS215/83 and to requirements of CSA B242.

- .3 Couplings shall be Victaulic Co. of Canada Ltd., ULC and FM approved grooved end pipe couplings to CSA B242, consisting of housings, gaskets, nuts and bolts. Housings shall be cast malleable (ASTM A-47) or ductile (ASTM A-536) iron cast in two (2) or more parts and secured together by heat treated carbon steel bolts and nuts conforming to ASTM A183. Gaskets shall be "EPDM" mechanical grooved coupling design pressure responsive elastomer gaskets, colour code green, suitable in all respects for the application.
- .4 Couplings for standpipe or sprinkler system piping with pressure less than 175 psi (1200 kPa) shall be style 005 "FIRELOK", other couplings shall be style 07 "ZERO-FLEX" with "EPDM" gaskets.
- .5 Couplings for piping risers, mains, and in Equipment Rooms shall be Style 07 "ZERO-FLEX" type with Grade "E" EPDM gaskets for water services suitable for temperatures -30°F (-34°C) to 230°F (110°C).
- .6 Fittings shall be malleable or ductile iron grooved end design fittings to accept grooved mechanical couplings without field preparation. Unless otherwise noted in succeeding Sections of this Division, Victaulic "FIT" tee, elbow, and similar fittings are not to be used.
- .7 Acceptable manufacturers are Victaulic Co. of Canada Ltd. and Gruvlok Corp.

## 2.8 PLASTIC PIPE, FITTINGS AND JOINTS

- .1 IPEX Inc., "BDS", or equal rigid PVC sewer pipe and fittings with solvent weld joints to CSA B182.1.
- .2 IPEX Inc., "Ultra- Rib", or equal rigid PVC sewer pipe and fittings with gasketed joints, Certified to CAN/CSA-B182.4 and to ASTM F794. Joints shall withstand 345 kPa hydrostatic pressure.
- .3 IPEX Inc., "BLUE BRUTE" Class 150 "Ring-Tite" rigid PVC pipe, and fittings certified to CAN/CSA-B137.2 and CAN/CSA-B137.2 respectively and FM approved.

## 2.9 PIPING UNIONS

- .1 Dart Union Co. of Canada Ltd., or equal malleable iron, ground joint, brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 250 psi (1725 kPa) steam at 500°F (260°C).
- .2 Malleable iron, ground joint, factory tested "RAILROAD" type screwed unions and union elbows with a brass to iron seat and a minimum pressure rating of 600 psi (4140 kPa) WOG (non-shock).

## 2.10 DIELECTRIC PIPE FITTINGS

- .1 Victaulic Co. of Canada Ltd., style 47 "Clearflow" dielectric pipe fittings to ASTM F-492, suitable for maximum temperatures of 225°F (107°C) and pressures of 300 psi (2070 kPa), and each complete with electro-zinc plated casing, NSF/FDA listed, chemically inert dielectric thermoplastic lining, ends to suit piping and overall fitting length matched to pipe size for maximum galvanic corrosion protection.
  - .1 Acceptable manufacturers are Victaulic Co. of Canada Ltd. and Grinnell Corporation.
- .2 Watts Regulator of Canada Ltd. Series 3000 dielectric pipe unions suitable for use with steam to 300°F (149°C) at 50 psi (345 kPa), to ANSI B16.39 and threaded to ANSI B2.1.



2.11 PIPING DRAIN VALVES

- .1 Minimum 300 psi (2070 kPa) water rated, 3/4" (19 mm) diameter straight pattern bronze globe valve or a bronze ball valve, each complete with a threaded outlet suitable for coupling connection of 3/4" (19 mm) diameter garden hose, and a cap and chain.
- .2 Acceptable manufacturers are Jenkins Valves, Crane Canada Inc., KITZ, Newman-Hattersley, Apollo, Toyo and Nibco.

2.12 PIPING AIR VENTS

- .1 Flair Hydraulics (Johnson Paterson), No. 16 or equal, 1/8" (3.2 mm) diameter manual valve with a wooden handle.

2.13 GATE, GLOBE AND SWING TYPE CHECK VALVES

- .1 Valves scheduled hereinafter are Jenkins Valves, unless otherwise noted.
- .2 All valves shall be, to the extent possible, the product of a single manufacturer and shall have the manufacturer's name, pressure rating and size clearly marked on the body.
- .3 Valves 2" (50 mm) and smaller shall be constructed of bronze. Valves 2-1/2" (65 mm) and larger shall have iron bodies and bronze mountings.
- .4 The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B-62 for valves rated up to 150 psi (1035 kPa) steam pressure, and ASTM B61 for valves rated at 200 psi (1380 kPa) and 300 psi (2070 kPa) steam pressure.
- .5 Bodies and bonnets of iron body valves shall conform to ASTM A-126, Class B.
- .6 Generally, valves 3" (75 mm) and smaller shall be complete with screwed ends, except for bronze valves installed in copper piping which shall be complete with soldering ends. Generally, valves larger than 3" (75 mm) shall be complete with flanged ends and proper flanged adapters to copper shall be provided where flanged valves are installed in copper piping.

- .7 Valves for installation in domestic water piping, heating system water piping and glycol solution piping with pressures less than 150 psi (1035 kPa), unless otherwise noted, shall conform to the following schedule:

VALVE TYPE	PRESSURE RATING WOG	ENDS	JENKINS FIG. NO.
BRONZE GATE	300 psi (2070 kPa)	SOLDERING	813
BRONZE GATE	200 psi (1380 kPa)	SCREWED	810
BRONZE GLOBE	300 psi (2070 kPa)	SCREWED	106-B
BRONZE GLOBE	300 psi (2070 kPa)	SOLDERING	106-BP
BRONZE GLOBE	400 psi (2760 kPa)	SCREWED	2050
BRONZE CHECK	250 psi (1725 kPa)	SCREWED	4092
BRONZE CHECK	300 psi (2070 kPa)	SOLDERING	4093
IRON GATE	200 psi (1380 kPa)	SCREWED	453
IRON GATE	200 psi (1380 kPa)	FLANGED	454
IRON GLOBE	200 psi (1380 kPa)	SCREWED	142
IRON CHECK	200 psi (1380 kPa)	SCREWED	588
IRON CHECK	200 psi (1380 kPa)	FLANGED	587

- .8 Wheels on bronze gate and globe valves, unless otherwise noted, shall be non-heating malleable iron finished in baked enamel. Wheels on iron body valves shall be cast iron wheels suitable for easy valve operation.
- .9 Acceptable manufacturers are Jenkins Valves, Crane Canada Inc., Kitz, Newman Hattersley Ltd., Milwaukee Valves, Toyo, RP+C (Conbraco Industries) and Nibco.

2.14 BALL VALVES

- .1 Unless otherwise noted, full bore, solid ball, forged brass or bronze ball valves as follows:
- .1 for domestic water piping, Kitz Corporation "Keepalloy" Series lead free valves having a weighted average lead content  $\leq 0.25\%$ . 600 psi (4140 kPa) W.O.G. with PTFE seats and soldering ends;
  - .2 for copper piping not used for domestic water service, Jenkins Valves Fig. No. 902J 600 psi (4140 kPa) W.O.G. with PTFE seats and soldering ends;
  - .3 for steel heating water piping, Jenkins Valves Fig. No. 901J, 600 psi (4140 kPa) W.O.G. rated with PTFE seats and seals, and screwed ends;
  - .4 for steel glycol solution heating piping, Jenkins Valves Fig. No. 32J, 600 psi (4140 kPa) W.O.G. rated with PTFE seats, packing and "D" ring, adjustable packing box and screwed ends.
  - .5 for natural gas and LP gas piping, with maximum 1/2 psig (3.45 kPag) pressure Neo Valves No. 460 CGA approved, with PTEF seats and screwed ends.
  - .6 for natural gas and LP gas piping, with maximum 125 psig (862 kPag) pressure, Neo Valves No. 525 CGA approved, full bore with chrome plated body, PTFE seats, screwed ends and suitable for -40 to 150°F (-40 to 65°C) Temperature range.
- .2 Ball valves in insulated piping shall be complete with extended handles to clear insulation.

- .3 Acceptable manufacturers for lead free valves used in domestic water services are Kitz Corporation "Keepalloy" series, or equivalent product offered by Jenkins Valves, Crane Canada Inc., Newman Hattersley Ltd., Milwaukee Valves, Toyo, RP+C (Conbraco Industries) or Nibco.
- .4 Acceptable manufacturers for valves used in services other than natural gas and domestic water are Jenkins Valves, Crane Canada Inc., Nibco Inc., Kitz, Milwaukee Valve Company, Newman-Hattersley, Toyo, Apollo, Victaulic Co. of Canada Ltd. and Watts Regulator of Canada Ltd.
- .5 Acceptable manufacturers of valves used in natural gas service are Neo Metals and Newman-Hattersley.

#### 2.15 BUTTERFLY VALVES

- .1 DeZurik of Canada Ltd., Fig. No. BGS-L1, lug body type, 175 psi (1200 kPa) rated, resilient seated butterfly valves, each complete with a stainless steel shaft, corrosion resistant disc, a seat suitable in all respects for the application, and a flange arrangement which maintains tight shut-off and the valve in position when one side of the connecting piping is removed.
- .2 Butterfly valves up to and including 6" (150 mm) diameter shall be equipped with "ON/OFF" lever handles. Butterfly valves 8" (200 mm) and larger shall be equipped with wheels and gear operators.
- .3 Acceptable manufacturers are DeZurik of Canada Ltd., Keystone Ltd., Watts Industries, Victaulic Co. of Canada Ltd. and Jenkins Valves.

#### 2.16 WAFER TYPE CHECK VALVES

- .1 Gulf Valve Co., "WAFER CHECK", threaded lug type, ANSI Series 150, 285 psi (1965 kPa) rated at 100 degrees F. (38 degrees C.), non-slam wafer check valves, each complete with a carbon steel body, stainless steel discs, a shaft, springs, disc stop and thrust bearings constructed of type 316 stainless steel, and seat materials to suit the application. The inside diameter of the valve must be equal the inside diameter of the connecting pipe.
- .2 Acceptable manufacturers are Gulf Valve Co., Checkrite, Mission (Duo-Chek II), and Victaulic Co. of Canada Ltd. (No. 715 dual disc).

#### 2.17 VALVE IDENTIFICATION TAGS

- .1 Embree Marking Systems or W.H. Brady Co., non-ferrous metal valve tags with a stamped consecutive number filled in with black paint, and a heavy-gauge non-ferrous metal chain, ring, or "S" hook for attaching the tag to a valve stem or handle.

#### 2.18 PIPING STRAINERS

- .1 Spirax Sarco Ltd., cast iron wye shaped strainers, type IF-125 screwed and/or type AF-250 flanged, each suitable for working pressures to 130 psi (890 kPa), and complete with a removable type 304 stainless steel strainer screen with perforations sized to suit the application.
- .2 Spirax Sarco Ltd., Type IT, screwed and/or type AF-250 flanged cast iron strainers, generally as specified above but suitable for working pressures in excess of 130 psi (890 kPa).
- .3 Strainers 2" (50 mm) diameter and larger shall be complete with blowdown pipe connection tappings.

- .4 Acceptable manufacturers are Spirax Sarco Ltd., Jenkins Valves, Crane Canada Inc., Nibco Inc., KITZ, Milwaukee Valve Company, Newman-Hattersley and Watts Industries. Where grooved end mechanical joint piping is allowed, acceptable manufacturers are Victaulic Co. of Canada and Grinnell Corp.

## 2.19 PIPING HANGERS AND SUPPORTS

- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
  - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
  - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
- .2 Hangers and supports for horizontal suspended piping as follows:
  - .1 adjustable steel clevis hanger – MSS Type 1;
  - .2 adjustable swivel ring band hanger – MSS Type 10;
  - .3 adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.
- .3 Supports for horizontal pipe on vertical surfaces as follows:
  - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
  - .2 heavy-duty steel pipe clip – MSS Type 26;
  - .3 single steel pipe hook – Myatt Fig. 156;
  - .4 epoxy coated steel pipe stays are not permitted.
- .4 Floor supports for vertical risers as follows:
  - .1 copper tubing riser clamp – MSS Type 8;
  - .2 heavy-duty steel riser clamp – MSS Type 8.
- .5 Supports for vertical piping on vertical surfaces as follows:
  - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
  - .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
  - .3 extension split pipe clamp – MSS Type 12;
  - .4 epoxy coated steel pipe stays are not permitted.
- .6 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
  - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;
- .7 Special hangers and supports for various applications as follows:
  - .1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
  - .2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
  - .3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;
  - .4 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
  - .5 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp.

- .8 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case minimum 9.5 mm (3/8") diameter.
- .9 Acceptable manufacturers are:
  - .1 E. Myatt & Co. Inc.;
  - .2 Anvil International Inc.;
  - .3 Empire Industries Inc.;
  - .4 Hunt Manufacturing Ltd.;
  - .5 Unistrut Canada Ltd.;
  - .6 Nibco Inc. "Tolco";
  - .7 Taylor Pipe Supports.

## 2.20 ACCESS DOORS

- .1 Acudor Acorn Limited, minimum No. 14 USS gauge (2.0 mm thick) prime coat painted steel flush access doors, each complete with a heavy frame and anchor, heavy-duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing features to suit the particular construction in which it is to be installed.
- .2 Access door sizes shall suit the concealed work for which they are supplied, and wherever possible they shall be of a standard size for all applications.
- .3 Access doors shall have the minimum dimension of 450mm x 450mm (18" x 18") at ceiling and 300mm x 300mm (12" x 12") at wall.
- .4 Access doors in fire rated construction shall be ULC listed and labelled and of a rating to maintain the fire separation integrity.
- .5 Where access doors are located in surfaces where special finishes are required, they shall be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout.
- .6 Acceptable manufacturers are Acudor Acorn Limited and The Williams Brothers Corporation.

## 2.21 PRESSURE GAUGES AND THERMOMETERS

- .1 Pressure gauges as follows:
  - .1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-1/2") diameter and each accurate to within 1% of scale range;
  - .2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;
  - .3 stainless steel rotary movement with stainless steel bushings and socket;
  - .4 clear acrylic window;
  - .5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;
  - .6 black pointer.
- .2 Pressure gauge accessories and additional requirements as follows:
  - .1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;
  - .2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber.
- .3 Thermometers as follows:
  - .1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;
  - .2 hermetically sealed stainless steel case with stainless steel ring;

- .3 dampened bimetal coil;
- .4 calibration adjustment screw;
- .5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;
- .6 black aluminum pointer;
- .7 double strength glass window;
- .8 12 mm ( $\frac{1}{2}$ " ) NPT connection with 6.4 mm ( $\frac{1}{4}$ " ) diameter stainless steel stem;
- .9 suitable thermowell.

.4 Acceptable manufacturers are:

- .1 H.O. Trerice Co.;
- .2 Weiss Instruments;
- .3 Ashcroft.

2.22 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 Guards for V-belt drives shall be removable four (4) sided, fully enclosed galvanized sheet steel guards to OSHA Standards, complete with 4-1/2" (112 mm) diameter tachometer openings covered with removable perforated galvanized plates at each shaft location.
- .2 Guards for flexible couplings shall be removable "U" shaped galvanized steel guards with a 0.0905" (2.3 mm) thick frame and expanded mesh face.
- .3 Guards for exposed fan blades, unless otherwise noted, shall be removable 3/4" (19 mm) galvanized steel wire mesh with galvanized steel frames.

2.23 ELECTRIC MOTORS

- .1 Motors shall conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA Standards unless otherwise noted.
- .2 All motors located outside the building, and inside the building in areas exposed to the weather or in sprinklered areas shall be totally enclosed fan cooled type unless otherwise noted, each with a service factor of 1.15 at 104°F (40°C) ambient temperature for all ratings.
- .3 All other motors shall be open drip-proof type unless otherwise noted.
- .4 Vertically mounted and submersible motors shall be purposely designed for mounting in this attitude.
- .5 The efficiency of single phase motors and three phase motors to 1 HP is to be in accordance with CAN/CSA C747. The efficiency of all three phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.
- .6 Unless otherwise noted, motors less than 1/2 HP (0.4 KW) size shall be single phase, 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature..
- .7 Unless otherwise noted, motors 1/2 HP (0.4 KW) size and larger shall be 3 phase, 60 cycle, 1750 RPM, NEMA design "B" for normal or "C" for high starting torque as required by the application.
- .8 Motors 1 HP (.746 kW) and larger shall be T-Frame, A.C., 3 phase heavy duty service.
- .9 Each motor shall be suitable for direct coupling or V-belt drive as required.

- .10 The frame of each 3-phase motor shall be constructed of corrosion-resistant cast iron with integrally cast feet except for smaller drip-proof motors which may have a rolled steel frame and welded feet. End brackets shall also be constructed of cast iron with precision machined bearing fits. The stator core assembly of each motor shall consist of stacked laminations of specially selected electrical grade steel. Insulation materials shall be non-hygroscopic and meet or exceed Class "B" definition. Motor temperature ratings shall not exceed Class "B" temperature limits when the motor is operated at full load in a maximum ambient temperature of 104°F (40°C).
- .11 Motors with pulse width modulating variable speed drives shall be inverter duty motors with Class "H" windings and Class "F" insulation.
- .12 Rotor windings shall be die-cast aluminum, surface treated for minimum rotor losses. Each shaft shall be dynamically balanced.
- .13 Bearings, unless otherwise noted, shall be grease lubricated with readily accessible plugs or fittings to allow "in-service" regreasing. Bearings shall be ball type, double shielded, single row width, made from vacuum degassed steel, except for large belted frames where roller bearings are required.
- .14 The motors for 2-speed motors shall be as above but 2-speed double winding motors.
- .15 Explosion proof motors shall be flame proof type with an explosion proof box and in accordance with CSA C22.2 No. 145 and Code requirements.
- .16 Motors 30 HP (22.4 kW) and larger shall be complete with or approved equal manual reset resistor type sensing elements with positive temperature co-efficients and tripping relays to disengage the motor starter when an abnormal temperature is sensed within the motor. Turn over the starter tripping relays to the electrical trade for integration into the respective motor starter.
- .17 Refer to starter schedule drawing(s) for motor voltage and phase requirements.
- .18 Acceptable manufacturers for motors 1 Hp. (0.75 kW) and larger are US Motors, TECO (Westinghouse Canada Inc.), WEG (V.J. Pamensky), Lincoln Electric Co. Ltd., and Toshiba International Corp.
- .19 Acceptable manufacturers for motors less than 1 Hp. (0.75 kW) are Canadian General Electric Co. Ltd., Emerson Electric Canada Ltd., Baldor Electric Co. and LEESON Electric (Canada) Ltd.

## 2.24 MOTOR STARTERS AND ACCESSORIES

- .1 Rockwell Automation Inc. (Allen-Bradley Canada Ltd.), NEMA type, motor starters in accordance with the following specification and the motor starter schedule(s), unless otherwise noted.
- .2 Unless otherwise noted, starters for single phase motors shall be Bulletin 600, 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or flush mounting NEMA enclosure to suit the application, and, where automatic operation is required, a separate "hand-off-automatic" selector switch in an enclosure to match the starter enclosure.
- .3 Unless otherwise noted, starters for 3 phase motors shall be combination "quick-make" and "quick-break" fused disconnects and full voltage, non-reversing magnetic starters for across-the-line service. Full protection of each phase shall be included in the starters by means of one (1) overload relay per phase per starter. Starters shall be equipped with "hand-off-automatic" switches, pilot lights, control transformers, auxiliary contacts, and other accessories as per the starter schedule(s).

- .4 Enclosures for starters located in sprinklered areas shall be NEMA 2. All other loose starter enclosures shall be NEMA 1 unless otherwise noted.
- .5 Motor control centres shall be Rockwell Automation Inc. (Allen-Bradley of Canada Ltd.) Bulletin "CENTERLINE 2100", 7-1/2' (2.28 m) high, multi-unit control centres, arranged as per the starter schedule. Each control centre shall be an NEMA Class 1, type "B" factory assembled, dead front, floor mounted control centre with tin plated copper bus and an NEMA type 1 or 2 enclosure as for loose starters specified above. Starters installed in control centres shall be as specified above and complete with load wiring and/or control wiring terminal boards. Motor control centres shall be complete with all required provisions for electric "line" and "load" side power connections.
- .6 Disconnects for motor control centres shall be heavy-duty, CSA approved, front operated with a handle suitable for padlocking in the "OFF" position and arranged so that the enclosure cover cannot be opened while the handle is in the "ON" position. Fusible units shall be complete with fuse clips for HRC fuses, unless otherwise noted. Enclosures shall be NEMA type 1 or 2 as specified for loose starters above. The ampere rating, number of poles, and fuse requirements shall be as indicated on the starter schedule(s).
- .7 Unless otherwise indicated, fuses shall be Form I, Class "J", HRC fuses for constant running equipment and Form II, Class "C", HRC fuses for motorized equipment that cycle "ON" and "OFF".
- .8 The motor starter(s) for 2-speed fan(s) shall be 2-speed type suitable for use with a two-speed double winding motor and complete with a forty-five (45) second time delay to allow the fan to coast down to low speed before it is operated at low speed.
- .9 Identification nameplates shall be engraved black-white-black Lamacoid, suitably sized, complete with bevelled edges and stainless steel securing screws. Engraving must be reviewed by the Consultant.
- .10 Each starter you supply must be capable of starting the particular motor under the imposed load.
- .11 Acceptable motor starter manufacturers are Rockwell Automation Inc. (Allen-Bradley Canada Ltd.), Furnas Electric, Square D Co. Ltd., Eaton (Cutler-Hammer Canada Ltd.), Canadian Controllers Ltd., and Siemens Canada.
- .12 Acceptable fuse manufacturers are Brush, Buss and Gould.

## 2.25 MECHANICAL WORK IDENTIFICATION MATERIALS

- .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (1/2" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-1/2") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:
  - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;
  - .2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
  - .3 supply stainless steel screws for securing nameplates in place;
  - .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.



- .2 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:
- VALVE V12  
 200 mm (8")  
 CHILL. WATER  
 NORMALLY OPEN
- .3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
- .1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
- .2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
- .4 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN
heating water drain	yellow	HTG. WTR. DRAIN

- .5 Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
yellow	black
green	white
red	white

- .6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

**3. Execution**

**3.1 GENERAL DUCTWORK INSTALLATION REQUIREMENTS**

- .1 Unless otherwise noted, locate and arrange horizontal ducts above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.
- .2 Unless otherwise noted, install all work concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas.
- .3 Install all ducts parallel to building lines.

- .4 Neatly group and arrange all exposed work.
- .5 Do not make duct joints in wall or slabs.
- .6 Locate all dampers and any other equipment which will or may need maintenance or repairs and which are installed in accessible construction so as to be easily accessible from access doors. Where dampers and similar ductwork accessories occur in vertical ductwork in shafts or partitions, locate the accessories at the floor level.
- .7 Ensure that equipment and material manufacturer's installation recommendations and instructions are followed unless otherwise noted herein or on the drawings, and unless such instructions and recommendations contradict governing codes and regulations.
- .8 Carefully clean all ducts and fittings prior to installation. Temporarily cap or plug ends of ducts and equipment which are open and exposed during construction.
- .9 Install ductwork which shall be insulated such that they have sufficient clearance to permit insulation to be applied continuously and unbroken around the duct except at fire barriers, in which case the insulation will be terminated at each side of the fire barrier.
- .10 Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing to the Consultant. Installation of your work will constitute acceptance of such surfaces as being satisfactory.
- .11 Ensure that exposed ferrous metal products, except ductwork and piping, have at least one (1) factory prime coat of alkyd metal primer, or paint such ferrous metal products with one (1) prime coat of alkyd metal primer on the job. Clean and wire brush ferrous metal products prior to application of prime coat.
- .12 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work. Quality of repair to finish shall be equal to finish provided by equipment manufacturer.

### 3.2 PIPE JOINT REQUIREMENTS

- .1 Ream all piping ends prior to making joints.
- .2 Properly cut threads in screwed steel piping and coat male threads, unless otherwise noted, with red lead, Teflon tape or paste, or an equivalent thread lubricant. After the pipe has been screwed into the fitting, valve, union, or piping accessory, not more than two (2) pipe threads shall remain exposed.
- .3 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove all scale and oxide from the bevels and leave same smooth and clean. Ensure that personnel doing welding work are CWB certified welders and qualified for the particular pressure application worked on, and that all tests required by governing authorities are carried out, including X-ray tests where required for certain applications.
- .4 Use Bonney Forge Ltd. or equal welding tees or welding outlet fittings for piping branches off mains, welded or socket type for pipes with welded fittings and threaded type for pipes with screwed fittings.
- .5 Make all flanged joints with Cranite Ltd. or equivalent gasket materials to suit the application, and suitable bolts and nuts. Bolts shall not be longer than the length necessary to screw the nut up flush to the end of the bolt.

- .6 Bolts used for flanged connections in all piping with a working pressure of 100 psi (690 kPa) and greater shall be ASTM A-193, Grade B-7, with heavy hexagon nuts to ASTM A-194, CL-2H.
- .7 Provide suitable washers between each bolt head and the flange and between each nut and the flange.
- .8 A random check of bolted flanged connections will be made by the Consultant to verify that flanged connections are properly mated with no shear force acting on bolts. Supply all labour to disconnect and reconnect the selected flanged joints as directed by the Consultant. If improperly mated joints are found, remove and reinstall the affected piping at your expense so that the flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
- .9 Unless otherwise specified, make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering.
- .10 Install type "MJ" mechanical joint fittings and couplings in accordance with the manufacturer's recommendations.
- .11 If grooved end fittings and couplings are used, ensure that the proper gaskets are used and are fully compatible with the fluid conveyed, and that all valves and piping accessories are suitable. Grooves in Schedule 40 steel pipe shall be cut and/or rolled. Grooves in Schedule 30 "Lightwall" steel pipe and in copper pipe shall be rolled. Apply fitting manufacturer supplied lubricant to gaskets prior to slipping on to pipe. Make arrangements with the coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required for pipe preparation and groove cutting and/or rolling machine operation, coupling installation, etc. Comply with manufacturer's latest published specifications, instructions and recommendations with respect to pipe, coupling and fitting preparation and installation, and support, anchoring and guiding of the grooved end piping system. For galvanized piping, touch-up damaged finish and exposed underlying surface (ie. groove) with zinc rich paint.
- .12 Solvent weld PVC piping in accordance with manufacturer's recommendations and ASTM 2855. Solvent welds must be two (2) part, consisting of a priming and cementing stage. Primer and cement used must be compatible with the pipe material and approved by the pipe manufacturer. Use IPS Weld-on 719 cementing compound for cementing 8" (200 mm) diameter and larger piping. Ensure solvent (or cement) is evenly distributed around the joint and joined pipe and sockets are properly aligned prior to solvent or cement taking set.
- .13 Install PVC piping with gasketed joints in accordance with manufacturer's latest published specifications, instructions and recommendations with respect to pipe, coupling and fittings preparation and installation, and support anchoring and guiding of the piping system. Apply pipe and fitting manufacture supplied lubricant to gasket prior to mating components.

### 3.3 INSTALLATION OF PIPE SLEEVES

- .1 Where pipes pass through concrete and/or masonry floors, walls, the roof, and any other such construction, provide pipe sleeves.
- .2 Pipe sleeves in poured concrete slabs, unless otherwise noted, shall be minimum No. 24 USS gauge (0.635 mm thick) flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves.
- .3 Sleeves in concrete or masonry walls shall be Schedule 40 galvanized steel pipe.
- .4 Sleeves in waterproof slabs shall be lengths of Schedule 40 mild galvanized steel pipe in accordance with the detail. Provide waterproof sleeves in the following locations:

- .1 in mechanical room floor slabs, except where on grade;
  - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
  - .3 in all floors equipped with waterproof membranes;
  - .4 in the roof.
- .5 Size sleeves, unless otherwise noted, to leave 1/2" (12 mm) clearance around the pipes, or where pipe is insulated, a 1/2" (12 mm) clearance around the pipe insulation.
  - .6 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:
    - .1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;
    - .2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
    - .3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.
      - .1 Thunderline Corp. (Power Plant Supply Co.) "Link Seal" model S-316 or Metraflex Co. "Metraseal" Type ES.
  - .7 For fire-rated construction, refer to section entitled Firestopping and Smoke Seal Systems.
  - .8 Where sleeves are required in masonry work, accurately locate and mark the sleeve position, and turn the sleeves over to the trade performing the masonry work for installation.
  - .9 Terminate sleeves for piping which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to extend 4" (100 mm) above the finished surface.
  - .10 "Gang" type sleeving will be permitted only with the approval of the Consultant.
  - .11 Where sleeves are provided for future piping, cap and seal both ends of the sleeved opening to the approval of the Consultant.

### 3.4 DUCT, DAMPER AND SIMILAR MATERIAL OPENINGS

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in poured concrete work, masonry, drywall and other building surfaces by the trade responsible for the particular construction in which the opening is required.
- .2 Ensure that openings for fire dampers to 14" (350 mm) high are sized to suit the damper arrangement with the folding blade out of the air stream.

### 3.5 PIPE JOINT REQUIREMENTS

- .1 Do not make pipe joints in walls or slabs.
- .2 Ream piping ends prior to making joints.
- .3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.

- .4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.
  - .5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.
  - .6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.
  - .7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
  - .8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.
  - .9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.
  - .10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.
  - .11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.
  - .12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.
  - .13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.
- 3.6 SLEEVE AND FORMED OPENING LOCATION DRAWINGS
- .1 Prepare and submit for review and forwarding to the concrete reinforcement detailer, drawings indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum.
  - .2 Begin to prepare such drawings immediately upon notification of acceptance of tender and award of contract.

3.7 INSTALLATION OF PIPE ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitably secured over all exposed piping passing through walls, floors, ceilings, partitions, furrings, and similar construction in finished areas.
- .2 Install the plates so that they are tight against the building surface concerned, and ensure that the plates completely cover pipe sleeves and/or openings, except where waterproof sleeves extend above floors.

3.8 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fasteners, anchors, braces and supports required to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner, capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where hangers are suspended from concrete slabs, install inserts before concrete is placed using inserts designed for the specific purpose.
- .4 Where built-in inserts are inaccessible due to subsequent installation of ducts, pipes or other installations, use anchors appropriate to the load requirements, including safety factor.
- .5 Where fastener installations are suspect, conduct on-site tests of installed fasteners, employing an independent testing laboratory acceptable to the Consultant, using properly engineered and calibrated force measuring meters.
- .6 Where the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure that the load is properly secured to the structure that is to support the products.
- .7 Provide reinforcing or connecting supports where required to distribute the loading to the structural components.
- .8 Do not use wood plugs and hammer impact fasteners. Anchors in floor topping fills are not acceptable. Secure anchors in floors to the structure.
- .9 Where a performance requirement is specified, submit engineering calculations and written verification signed by a registered professional engineer that the installation has been inspected and is structurally sound and in accordance with design requirements.
- .10 Fastenings which cause spalling or cracking of the structure or products to which anchorage is made are not acceptable.
- .11 Obtain the Consultant's consent before using explosive actuation fastening devices. If consent is obtained, comply with CSA A166.
- .12 Space anchors within limits of load bearing or shear capacity and ensure they provide positive permanent anchorage.

3.9 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES

- .1 Provide shut-off valves in piping connections to equipment, to isolate piping risers and other sections of systems as shown, and wherever else indicated on the drawings.
- .2 Provide a check valve in the discharge piping of every pump, and in piping wherever else shown.
- .3 Shut-off valves in piping where a balancing or throttling effect is required such as inlet piping to water coils shall be globe type unless otherwise noted. All other shut-off valves shall be ball type to and including 2" (50 mm) diameter, butterfly type 2-1/2" (65 mm) diameter or larger, or, where required, gate type.
- .4 Ball valves shall not be used in piping conveying fluid below 60°F (15°C).
- .5 Shut-off valves in natural gas piping shall be lubricated plug types for piping larger than 2" (50 mm) and for piping 2" (50 mm) and smaller including branch piping connections to equipment, CGA approved ball type valves.
- .6 Do not use ball or butterfly valves to replace globe valves.
- .7 Check valves shall be swing check type installed in horizontal piping, however, provide lug body type wafer check valves in vertical piping where space conditions do not permit the use of swing type check valves in horizontal piping.
- .8 Note that discharge accessories provided with vertical in-line circulating pumps specified in Section 23 21 00 are complete with integral check valves.
- .9 Valve stems in horizontal piping shall be pitched upward.
- .10 Locate all shut-off valves in piping such that valve handles are positioned for easy operation. Wherever possible, install shut-off valves at uniform height.

3.10 VALVE TAGGING AND CHART

- .1 Tag valves and prepare a valve tag chart in accordance with following requirements:
  - .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;
  - .2 prepare a computer printed valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
  - .3 frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
  - .4 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;
  - .5 hand an identified CD of valve tag chart to Consultant at same time O & M Manuals are submitted.
- .2 Valve tag numbering must be approved by the Consultant.
- .3 Chart(s) must be approved by the Consultant.
- .4 Where valves occur above suspended ceilings, provide small red stick-on markers or pins on the ceiling support members or in ceiling tiles at valve locations.

3.11 VALVE IDENTIFICATION

- .1 Use the following colour identification dots on ceiling grid to locate valves enclosed in ceiling space:
  - .1 Dark Blue Dots – Domestic Cold Water
  - .2 Orange Dots – Domestic Hot Water
  - .3 Red Dots – Heating Water
  - .4 Yellow Dots – Any gas valves that are above ceiling
  - .5 Green Dots – Balancing Dampers

3.12 INSTALLATION OF PIPING STRAINERS

- .1 Provide strainers in piping where shown on the drawings and wherever specified herein or on the drawings.
- .2 Equip strainers 2" (50 mm) diameter and larger with valved blowdown piping. Terminate blowdown piping over the nearest funnel and floor drain unless otherwise noted.
- .3 Locate all strainers so they are easily accessible for service.
- .4 Note that strainers are integral with inlet suction piping accessories specified in Section 23 21 00 with vertical in-line pumps.

3.13 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- .1 Provide required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
- .3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.
- .4 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.
- .5 Space hangers and supports in accordance with following:
  - .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
  - .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
  - .3 copper and steel pipe – hang or support at spacing in accordance with following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')



PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .4 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints.
- .6 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.
- .7 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
- .8 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
- .9 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .10 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.
- .11 Do not support piping from steel deck without written consent from Consultant.

3.14 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to all valves, cleanouts, strainers, duct access doors, and other similar mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on the drawings.
- .2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.
- .3 Group piping and ductwork to ensure the minimum number of access doors is required.
- .4 Access doors will be installed by the trades responsible for the particular type of construction in which the doors are required.

3.15 INSTALLATION OF VALVES

- .1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:

- .1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
- .2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;
- .3 unless otherwise specified, provide a check valve in discharge piping of each pump;
- .4 valve sizes are to be same as connecting pipe size;
- .5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;
- .6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

### 3.16 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

- .1 Provide pressure gauges with cocks in the following locations:
  - .1 wherever shown and/or specified on the Drawings or in the Specification.
- .2 Provide an angle type or straight type (as required) thermometer in the following locations:
  - .1 in supply, return and exhaust ductwork;
  - .2 wherever else shown and/or specified herein or on the Drawings or in the Specification.
- .3 Locate and mount all instruments so they are easily readable.

### 3.17 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 Protect all exposed rotating parts such as belts drives, couplings, fly wheels, and fan wheels on all mechanical equipment with a guard. Alternatively, where belt guards cannot be installed, provide lockable doors with metal screens around all exposed rotating parts.
- .2 Secure guards to the equipment or equipment base but do not bridge sound or vibration isolation.
- .3 Where equipment oil level gauges, oil reservoirs, grease cups or grease gun fittings are integral with the equipment but are not easily accessible for service, extend to accessible locations.

### 3.18 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

- .1 Unless otherwise noted, supply a motor starter for each item of motorized equipment which you provide.
- .2 Where three (3) phase starters are indicated and scheduled in motor control centre enclosures, supply the control centres complete with starters and bolt the assemblies to concrete housekeeping pads where shown.
- .3 Where package type equipment with integral starters, or equipment with starters integral in loose control panels supplied with the equipment (either by Mechanical Divisions or as part of the work of other Divisions) is fed from a motor control centre, provide a disconnect switch in the motor control centre in lieu of a starter. Refer to the starter schedule(s) for requirements.
- .4 "Line" side power wiring to motor control centres and "load" side power wiring from control centres to equipment will be done as part of the electrical work.
- .5 Unless otherwise noted or shown on the drawings, single phase starters will be mounted adjacent to the equipment they serve and connected complete as part of the electrical work. Hand the starters to the electrical trade at the site at the proper time.

- .6 Motor starter interlocking will be done as part of the electrical work in accordance with requirements specified in Mechanical Divisions, and as outlined on the starter schedule(s). Equip each starter to be interlocked with all required contacts and control connection accessories.
- .7 Provide an identification nameplate on each motor starter or disconnect located in a motor control centre or on a motor starter panel, on each individually mounted starter which you supply, and on each disconnect which is provided by Electrical Division for motorized equipment which you supply.

### 3.19 IDENTIFICATION PAINTING

- .1 Identify exposed piping and ductwork in locations as follows:
  - .1 at every end of every duct run;
  - .2 adjacent to each valve, strainer, damper and similar accessory;
  - .3 at each piece of connecting equipment;
  - .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
  - .5 at 20' (6 m) intervals on pipe and duct runs exceeding 20' (6 m) in length;
  - .6 on each side of special fittings and branch connections;
  - .7 at least once in each room, and at least once on pipe and duct runs less than 20' (6 m) in length.
- .2 Identify concealed ductwork in locations as follows:
  - .1 at points where pipe or ducts enter and leave rooms, shafts and similar areas;
  - .2 at maximum 20' (6 m) intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
  - .3 at each access door location;
  - .4 at each piece of connected equipment, automatic valve, etc.
- .3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.
- .4 Identification for ductwork shall consist of neatly stencilled, painted 1" (25 mm) high lettering to indicate the system the duct is associated with and the duct service, i.e., "SYSTEM ACS-1-SUPPLY", and stencilled directional arrows to indicate air flow. On insulated ductwork with a paintable finish apply the identification directly to the duct insulation. On uninsulated ducts apply the lettering to a rectangular painted white background. Identification paint colour shall be black.
- .5 Equipment identification wording shall be minimum 1" (25 mm) high stencilled lettering and shall indicate the use of the particular pieces of equipment. Abbreviations will not be permitted.
- .6 Note that use of Brady Ltd. or equal plastic coated cloth material colour coded markers with lettering, arrows, and waterproof adhesive backing will be permitted in lieu of painting and stencilling if the surface the marker is to be applied to is dry and sealed with clear lacquer, and clear lacquer is applied over the marker after installation.
- .7 Tag valves and prepare a valve tag chart in accordance with following requirements:
  - .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;

- .2 prepare a computer printed valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
- .1 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
- .2 frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
- .3 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;
- .4 hand an identified CD of valve tag chart to Owner at same time O & M Manuals are submitted.

### 3.20 PIPE LEAKAGE TESTING

- .1 After new piping has been placed in position and all branch piping installed, but before the piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test all piping in the presence of governing authorities, if required, and the Consultant or his authorized representative.
- .2 Domestic Water Piping:
  - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
- .3 Heat Transfer (HVAC) System Piping
  - .1 Test piping with cold water at a pressure of 1035 kPa (150 psi) for a minimum of 2 hours.
- .4 General Regarding All Piping:
  - .1 Temporarily remove all piping system specialties which may be damaged by test pressures, prior to pressure testing the systems.
  - .2 When testing is carried out below the highest level of the particular system, increase the test pressure by the hydrostatic head 1 psi (7 kPa) for every 2' (600 mm) below the high point.
  - .3 Include for temporary piping connections required to properly complete the tests.
  - .4 When pressure testing any system, valve off any equipment which has a working pressure lower than the system test pressure.
  - .5 Make tight all leaks found during tests while the piping is under pressure, and if this is impossible, remove and refit the piping and reapply the test until satisfactory results are obtained.
  - .6 Where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions.
  - .7 Tests may be done in sections, as later approved.
  - .8 Maintain written logs of all tests performed and keep the logs available at the site for review upon request.
  - .9 In addition to the leakage tests specified above, demonstrate proper flow throughout the systems including mains, connections and equipment, as well as proper venting and drainage. Include for any necessary system adjustments to achieve the proper conditions.

### 3.21 MECHANICAL PLANT PERFORMANCE AND ACCEPTANCE TESTS

- .1 After individual pieces of equipment have been tested and accepted, but prior to operating tests specified hereinafter, forward to the Consultant a letter stating that the entire mechanical plant is complete in all respects, has been checked and tested, and is ready for start-up. When the letter has been received, the Consultant will visit the site for purpose of witnessing a performance and acceptance test of the entire plant.

- .2 Include for all required labour for the performance test and any adjustments required due to the results of the test, and ensure that competent and qualified equipment manufacturer's representatives are present during the test.
- .3 When the entire mechanical plant is ready for acceptance, but before acceptance of same, subject the entire plant to a continuous run for the length of time required for the purpose of demonstrating that all apparatus, materials, and systems are in perfect working order, that all controls and operating services are properly adjusted, that all units are heating and/or cooling properly, and that the systems provide uniform temperatures inside the building regardless of outside temperatures or conditions. Make the tests under the direction of the Consultant, and if the plant is not in proper operating condition, the Owner reserves the right, if all defects are not properly rectified, to employ other parties to make the necessary alterations and put the systems in proper working order, at your expense.
- .4 Note that the testing specified above must be complete prior to issue of a Certificate of Substantial Performance.

### 3.22 EQUIPMENT BASES AND SUPPORTS

- .1 Unless otherwise noted, set all floor mounted equipment on 4" (100 mm) high concrete housekeeping pads 4" (100 mm) wider and longer than the equipment base dimensions.
- .2 Supply dimensioned drawings, equipment base templates and anchor bolts for proper setting and securing of equipment on pads, and be responsible for all required levelling, alignment, and grouting of the equipment.
- .3 For equipment such as shell and tube heat exchangers provide prime coat painted structural steel stands flange bolted to housekeeping pads.
- .4 Provide prime coat painted structural black steel angle or channel frames and brackets for all surface wall mounted equipment not specifically designed for surface wall mounting, unless otherwise noted.

### 3.23 CONCRETE WORK FOR MECHANICAL SERVICES

- .1 Provide all concrete work, including reinforcing and formwork, required for mechanical work. All concrete shall be minimum 3,000 psi (20,700 kPa) ready-mix concrete provided in accordance with requirements of Division 03, unless otherwise noted.

### 3.24 FINISH PAINTING OF MECHANICAL WORK

- .1 Unless otherwise noted, finish painting of exposed mechanical work will be done as part of the work of Division 09.
- .2 Touch-up paint pre-finished equipment and provide identification painting of conduit, duct and equipment to the Consultant's approval. Confirm colour requirements prior to ordering.

### 3.25 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

- .1 Pack and seal the void between the pipe opening and the pipe or pipe insulation for the length of the opening as follows:
  - .1 pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal;
  - .2 pack and seal openings in fire rated walls and slabs as specified in Section entitled Firestopping and Smoke Seal Systems;

- .3 pack openings in exterior wall above grade with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;
  - .4 seal exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.
- .2 Thunderline Corp. (Power Plant Supply Co.) "Link Seal" model S-316 or Metraflex Co. "Metraseal" Type ES.

END OF SECTION

## 1 GENERAL

### 1.01 APPLICATION

- .1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### 1.02 SUBMITTALS

- .1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.
- .2 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

## 2 PRODUCTS

### 2.01 GENERAL

- .1 Vibration isolation products are to be in accordance with drawing schedule and details, and as specified below.
- .2 Springs are to be stable, colour coded, selected to operate at no greater than  $\frac{2}{3}$  solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.
- .3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.
- .4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.
- .5 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

### 2.02 ISOLATION PADS

- .1 Sandwich type pads, 20 mm ( $\frac{3}{4}$ ") nominal thickness, selected for 3.2 mm ( $\frac{1}{8}$ ") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum #10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.
- .2 Acceptable products are:
  - .1 Vibro-Acoustics Ltd. Type NSN;
  - .2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";

- .3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;
- .4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;
- .5 J. P. America Inc. Type JSJ.

### **2.03 OPEN SPRING MOUNTS**

- .1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm (5/8") diameter level adjustment bolt.
- .2 Acceptable products are:
  - .1 Vibro-Acoustics Ltd. Type FS;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type A;
  - .3 Kinetics Noise Control Vibron Products Group Type FDS;
  - .4 Mason Industries Inc. Type SLFH;
  - .5 J. P. America Inc. Type TSO.

### **2.04 CLOSED SPRING MOUNTS**

- .1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.
- .2 Acceptable products are:
  - .1 Vibro-Acoustics Ltd. Type CM;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Types B and C;
  - .3 Kinetics Noise Control Vibron Products Group Type FLS;
  - .4 Mason Industries Inc. Type C;
  - .5 J. P. America Inc. Type TSC.

### **2.05 TOTALLY RETAINED SPRING MOUNTS**

- .1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.
- .2 Acceptable products are:



- .1 Vibro-Acoustics Ltd. Type CSR;
- .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type MS;
- .3 Kinetics Noise Control Vibron Products Group Type SM;
- .4 Mason Industries Inc. Type SLRSO;
- .5 J. P. America Inc. Type TSR.

## **2.06 SPRING HANGERS**

- .1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.
- .2 Acceptable products are:
  - .1 Vibro-Acoustics Ltd. Type SHR-SN;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Series HRSA;
  - .3 Kinetics Noise Control Vibron Products Group. Type SRH;
  - .4 Mason Industries Inc. Type 30N;
  - .5 J. P. America Inc. Type TSH.

## **2.07 NEOPRENE HANGER ISOLATORS**

- .1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.
- .2 Acceptable products are:
  - .1 Vibro-Acoustics Ltd. Type NH;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type HR;
  - .3 Kinetics Noise Control Vibron Products Group Type RH;
  - .4 Mason Industries Inc. Type HD or WHD;
  - .5 J. P. America Inc. Type TRH.

## **3 EXECUTION**

### **3.01 INSTALLATION OF VIBRATION ISOLATION MATERIALS**

- .1 Provide vibration isolation products for mechanical work in accordance with drawing schedule and details, and requirements specified herein and/or on drawings.

- .2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.
- .3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.
- .4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
- .5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:
  - .1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;
  - .2 steel bases are to clear the sub-base by 25 mm (1");
  - .3 concrete bases are to clear the sub-base by 50 mm (2").
- .6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:
  - .1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
  - .2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
  - .3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;
- .7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").
- .8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.
- .9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.
- .10 Erect roof curb vibration isolation in accordance with instructions shipped with assembly. Match vibration isolation with associated roof top unit and orient isolation as identified by manufacturer to ensure proper loading and optimum performance. Caulk top of roof curb with 2 beads of caulking provided and centre isolation assembly onto roof curb and, unless otherwise noted, screw in place with 50 mm (2") lag screws at 900 mm (36") O.C. Position gasket on top rail or alternatively, caulk with 2 beads of caulking provided and orient and lower roof top unit onto isolation rails and, unless otherwise noted, screw unit into top rail with 25 mm (1") lag screws at 900 mm (36") O.C. After roof top unit is secured in place, but before damageable work is installed, spray each isolated equipment assembly with water and correct any water leaks.

- .11 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to Consultant.
- .12 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

**END OF SECTION**

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

### **1.02 DEFINITIONS**

- .1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.
- .2 "exposed" – means exposed to normal view during normal conditions and operations.
- .3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.
- .4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

### **1.03 SUBMITTALS**

- .1 Submit a product data sheet for each insulation system product.
- .2 Submit a fabrication drawing for each custom made cover to indicate material and fabrication details, and a 300 mm (12") square sample of proposed cover material.
- .3 In accordance with Part 3 of this Section, submit a letter from fire rated duct wrap supplier to certifying duct wrap has been properly installed.
- .4 Submit a colour chart for coloured lagging adhesive for canvas jacketed insulation.

### **1.04 QUALITY ASSURANCE**

- .1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.
- .2 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .3 Ensure surfaces to be insulated are clean and dry.
- .4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .5 Company with sub-contract for mechanical insulation work is to be a member in good standing of Thermal Insulation Association of Canada.
- .6 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

## **2 PRODUCTS**

### **2.01 FIRE HAZARD RATINGS**

- .1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

## 2.02 THERMAL PERFORMANCE

- .1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

## 2.03 PIPE INSULATION MATERIALS

- .1 Horizontal pipe insulation at hangers and supports are to be equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 Flexible foam elastomeric is to be closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96, Procedure B, and required installation accessories. Acceptable products are:
  - .1 Armacell AP/Armaflex SS;
  - .2 IK Insulation Group K-Flex "LS" Self-Seal Pipe Insulation.
- .3 Fire rated pre-moulded mineral wool is to be non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with ULC S115 and ULC-S101 firestopping. Acceptable products are:
  - .1 Roxul "Tecton 1200";
  - .2 IIG (Johns Manville Inc.) MinWool-1200;
  - .3 Paroc 1200.
- .4 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket. Acceptable products are:
  - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
  - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
  - .3 Manson Insulation Inc. "ALLEY K APT";
  - .4 Owens Corning "Fiberglas" Pipe Insulation.
- .5 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m<sup>3</sup> (1-½ lb/ft<sup>3</sup>) density, with a factory applied vapour barrier facing. Acceptable products are:
  - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;

- .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
- .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
- .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .6 Pre-moulded weatherproof jacketed mineral fibre is to be Knauf Insulation "Redi-Klad 1000" sectional, sleeve type pipe insulation with a self-sealing weather-proof jacket and a 100 mm (4") butt joint sealing strip with each section.

#### **2.04 BARRIER-FREE LAVATORY PIPING INSULATION KITS**

- .1 Removable, flexible, reusable, white moulded plastic insulation kits for barrier-free lavatory drain piping and potable water supplies exposed under lavatory.
- .2 Acceptable products are:
  - .1 Truebo "Lav-Guard 2" E-Z Series;
  - .2 Zeston "SNAP-TRAP";
  - .3 McGuire Manufacturing Co. Inc. "ProWrap".

#### **2.05 EQUIPMENT INSULATION MATERIALS**

- .1 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m<sup>3</sup> (1-½ lb/ft<sup>3</sup>) density, with a factory applied vapour barrier facing. Acceptable products are:
  - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
  - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
  - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
  - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .2 Semi-rigid mineral fibre board is to be roll form, moulded insulation to ASTM C1393, with a factory applied vapour barrier facing consisting of laminated aluminum foil and kraft paper. Acceptable products are:
  - .1 Knauf Fiber Glass Pipe and Tank Insulation;
  - .2 Manson Insulation Inc. "AK FLEX";
  - .3 Johns Manville Inc. Pipe and Tank Insulation "Micro-Flex";
  - .4 Multi-Glass Insulation Ltd. "MULTI-FLEX MF";
  - .5 Owens Corning Pipe and Tank Insulation;
  - .6 Glass-Cell Fabricators Ltd. "R-Flex".
- .3 Semi-rigid mineral wool blanket is to be equal to Roxul "Enerwrap MA 960" flexible, black fibrous scrim faced mineral wool blanket insulation to ASTM C553.

- .4 Closed cell foamed glass is to be Pittsburgh Corning "FOAMGLAS" expanded, rigid board and block type insulation with a liquid or vapour permeability rating (as per ASTM C240) of 0.00.

## 2.06 REMOVABLE/REUSABLE INSULATION COVERS

- .1 Valve, etc. covers are to be NO SWEAT reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit the application and an insulation thickness equal to adjoining insulation.
- .2 Custom manufactured equipment covers conforming to shape of item to be insulated, designed to be easily removable and replaceable to suit use and maintenance procedures of particular item, and to provide adequate personnel protection. Covers are to be complete with minimum 95 kg/m<sup>3</sup> (6 lb/ft<sup>3</sup>) density ceramic fibre insulation sewn between minimum 542.5 g/m<sup>2</sup> (1.8 oz/ft<sup>2</sup>) weight silicone impregnated fibreglass fabric in a quilted pattern using double stitches made with Kelvar or Teflon coated fibreglass thread. Overlap flaps are to be secured using laces, snaps, or Velcro double stitched in place. Acceptable manufacturers are:
  - .1 Crosby Dewar Inc.;
  - .2 Insufab Systems Inc.;
  - .3 ADL Insulflex Inc.;
  - .4 Firwin Corp.;
  - .5 GlassCell Isofab Inc.

## 2.07 DUCTWORK SYSTEM INSULATION MATERIALS

- .1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m<sup>3</sup> (3 lb/ft<sup>3</sup>) density, with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:
  - .1 Knauf Fiber Glass Insulation Board with FSK facing;
  - .2 Manson Insulation Inc. "AK BOARD FSK";
  - .3 Johns Manville Inc. Type 814 "Spin-Glas";
  - .4 Owens Corning 703.
- .2 Semi-rigid mineral fibre board is to be roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing. Acceptable products are:
  - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
  - .2 Glass-Cell Fabricators Ltd. "R-FLEX";
  - .3 Owens Corning Pipe and Tank Insulation;
  - .4 Johns Manville Inc. Pipe and Tank Insulation.

- .3 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m<sup>3</sup> (1½ lb/ft<sup>3</sup>) density, 40 mm (1-½") thick, with a factory applied vapour barrier facing. Acceptable products are:
  - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
  - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
  - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
  - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .4 Pre-moulded calcium silicate is to be rigid block and sheet insulation. Acceptable products are:
  - .1 Johns Manville Inc. "Thermo-12 Gold";
  - .2 Industrial Insulation Group "Thermo-12 Gold".
- .5 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A. Acceptable products are:
  - .1 Armacell "AP/Armaflex SA";
  - .2 IK Insulation Group "K-Flex Duct Wrap", S2S.

## 2.08 FIRE RATED DUCT WRAP

- .1 Flexible, non-combustible, blanket type mineral fibre duct wrap completely encapsulated in reinforced foil, suitable for installation with zero clearance to combustibles (for grease ducts), and ULC tested and listed (ULC Designs FRD-17 & 23 for ventilation ducts, ULC Design FRD-19 for kitchen exhaust/grease duct) to facilitate a 2 hour fire resistance rating (76 mm [3"] thick) to kitchen grease exhaust duct in accordance with requirements of NFPA-96, and/or a 1 or 2 hour fire resistance rating (38 mm [1-½"] thick) to ventilation or pressurization ductwork in accordance with requirements of ISO 6944.
- .2 Acceptable manufacturers are:
  - .1 3M Fire Barrier Duct Wrap 615;
  - .2 CL4 Inc. "CL4Fire";
  - .3 Unifrax Corp. "FyreWrap Elite 1.5";
  - .4 Morgan Thermal Ceramics "FireMaster FastWrap XL".

## 2.09 INSULATING COATINGS

- .1 Equal to Robson Thermal Manufacturing Ltd. insulating coatings as follows:
  - .1 anti-condensation coating, "No Sweat-FX";
  - .2 thermal insulating coating, "ThermaLite".



## 2.10 INSULATION FASTENINGS

- .1 Wire – minimum #15 gauge galvanized annealed wire.
- .2 Wire with Mesh – minimum #15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.
- .3 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.
- .4 Stainless Steel Banding – equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.
- .5 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.
- .6 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.
- .7 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.
- .8 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.
- .9 Closed Cell Foamed Glass Insulation Adhesive – Pittsburgh Corning PC88 multi-purpose 2-component adhesive.
- .10 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
- .11 Screws – No. 10 stainless steel sheet metal screws.

## 2.11 INSULATION JACKETS AND FINISHES

- .1 Canvas Jacket Material – ULC listed and labelled, 25/50 fire/smoke rated, roll form, minimum 170 g (6 oz.).
- .2 Roll Form Sheet and Fitting Covers – minimum 15 mm (1/2") thick white PVC, 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories. Acceptable products are:
  - .1 Proto Corp. "LoSMOKE";
  - .2 The Sure-Fit System "SMOKE-LESS 25/50";
  - .3 Johns Manville Inc. "Zeston" 300.

- .3 Rigid Aluminium Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminum fittings with weather locking edges.
- .4 Stainless Steel Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.254 mm (0.010") thick type 304 embossed stainless steel jacket material to ASTM A240, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to cover end to end joints, and 2-piece pressed stainless steel fittings with weather locking edges.
- .5 Adhesive backed flexible aluminium is to be MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.
- .6 Heat resistant, trowel consistency thermal insulating and finishing cement to CAN/CGSB 51.12, and suitable for the application.
- .7 Foamed glass insulation protective coating is to be Pittsburgh Corning "PITTCOTE 404" flexible acrylic latex weather barrier coating, white unless otherwise specified.
- .8 Flexible foam elastomeric insulation protective coating equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

### **3 EXECUTION**

#### **3.01 GENERAL INSULATION APPLICATION REQUIREMENTS**

- .1 Unless otherwise specified, do not insulate following:
  - .1 factory insulated equipment and piping;
  - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
  - .3 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;
  - .4 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;
  - .5 heated liquid system pump casings, valves, strainers and similar accessories;
  - .6 heating system expansion tanks;
  - .7 fire protection pump casings;
  - .8 manufactured expansion joints and flexible connections;
  - .9 acoustically lined ductwork and/or equipment;
  - .10 factory insulated flexible branch ductwork;
  - .11 fire protection system water storage tanks;

- .12 piping unions, except for unions in "cold" category piping.
- .2 Install insulation directly over pipes and ducts, not over hangers and supports.
- .3 Install piping insulation and jacket continuous through pipe openings and sleeves.
- .4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from the action of condensation at its junction with metal.
- .6 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
- .7 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
- .8 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
- .9 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

### **3.02 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS**

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

### **3.03 PIPE INSULATION REQUIREMENTS – MINERAL FIBRE**

- .1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:
  - .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
  - .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
  - .3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;
  - .4 domestic hot water piping, greater than or equal to 40 mm (1½") dia. – 40 mm (1-½") thick;

- .5 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal underground mains – 25 mm (1") thick;
- .6 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;
- .7 hot water heating piping, supply and return, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;
- .8 hot water heating piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
- .9 boiler feedwater piping complete – 25 mm (1") thick;
- .10 boiler blowdown piping complete – 40 mm (1-½") thick;
- .11 drum drip(s) in dry zone standpipe and/or sprinkler system piping – 50 mm (2") thick;
- .12 refrigerant suction piping (between compressor and evaporator coil) inside building – 25 mm (1") thick;
- .13 refrigerant hot gas piping (between compressor and condenser) inside building – 25 mm (1") thick;
- .14 refrigerant hot gas by-pass piping (between compressor discharge and evaporator coil) inside building – 25 mm (1") thick;
- .2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.
- .3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.
- .4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.
- .5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.
- .6 Drum drips in dry zone sprinkler and/or standpipe system piping will be traced with electric heating cable as part of electrical work, and are generally not shown on drawing(s). Confirm number and size of drum drips required with trade providing piping and include for insulation to suit. Wherever possible drum drips will be located in heated areas.

- .7 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

### **3.04 PIPE INSULATION REQUIREMENTS – MINERAL WOOL**

- .1 Generally, install insulation on piping as specified above for mineral fibre insulation.
- .2 Generally, install insulation on fittings as specified above for mineral fibre insulation but cover with canvas, not PVC fitting covers.

### **3.05 PIPE INSULATION REQUIREMENTS – FLEXIBLE FOAM ELASTOMERIC**

- .1 Install flexible elastomeric pipe insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Insulate following pipe with flexible elastomeric pipe insulation of thickness indicated:
  - .1 refrigerant suction and hot gas piping outside building – 25 mm (1") thick.

### **3.06 PIPE INSULATION REQUIREMENTS – CLOSED CELL FOAMED GLASS**

- .1 Install closed cell foamed glass insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants, and jacketing to produce a water-tight installation. Insulate following pipe with closed cell foamed glass of thickness indicated:
  - .1 piping located outside building and indicated to be heat traced – minimum 50 mm (2") thick.

### **3.07 PIPE INSULATION REQUIREMENTS – FIRE RATED INSULATION**

- .1 Where pipe (inside building and above ground) which is to be insulated as specified above penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on portion of pipe in fire barrier and for a distance of 50 mm (2") on either side of fire barrier. Insulation thickness is to be as specified, but in any case minimum 25 mm (1").

### **3.08 INSTALLATION OF BARRIER FREE LAVATORY INSULATION KITS**

- .1 Provide manufactured insulation kits to cover exposed drainage and water piping under barrier free lavatories.

### **3.09 EQUIPMENT INSULATION REQUIREMENTS – BLANKET TYPE MINERAL FIBRE**

- .1 Insulate following equipment with mineral fibre blanket type insulation of thickness indicated:
  - .1 domestic cold water pump casings – 40 mm (1-½") thick;
  - .2 roof drain sumps where inside the building – 25 mm (1") thick;
  - .3 water meter(s) – 40 mm (1-½") thick;

- .2 Unless otherwise noted, wrap equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate insulation in place with a full coverage of adhesive and secure with wire. Apply a jacket of insulation vapour barrier material secured in place with adhesive or sealant tape.
- .3 Cover roof drain sumps with purpose made PVC fitting covers.
- .4 Lay fibreglass blanket on radiant ceiling panels after testing is complete.

### **3.10 EQUIPMENT INSULATION REQUIREMENTS – SEMI-RIGID MINERAL FIBRE**

- .1 Insulate following equipment with semi-rigid mineral fibre board insulation of thickness indicated:
  - .1 heating main air separator – 40 mm (1-½") thick;
- .2 Install insulation as required to fit shape and contour of equipment. Secure insulation in place with adhesive, and with aluminum straps on 450 mm (18") centres. Apply a 6 mm (¼") thick skim coat of insulating cement, then, when insulating cement has dried, apply a 6 mm (¼") thick coat of cement trowelled smooth.
- .3 For "cold" equipment, prime insulation with suitable sealer and apply a jacket of glass thread reinforced foil and kraft paper vapour barrier jacket material laminated in place with a full coverage of adhesive.
- .4 Provide removable and replaceable insulated metal covers for equipment with removable heads to permit heads to be removed and replaced without damaging adjacent insulation work.

### **3.11 EQUIPMENT INSULATION REQUIREMENTS – REMOVABLE/REUSABLE TYPE**

- .1 Provide custom designed and manufactured removable and reusable insulation covers for following:
  - .1 150 mm (6") dia. and larger piping strainers, backflow preventers, etc.;
- .2 Provide "wrap type" removable and reusable insulation covers for "cold" circuit balancing valves, backflow preventers, and similar items, and for steam traps and similar items requiring service in piping less than 150 mm (6") dia.

### **3.12 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE**

- .1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:
  - .1 outside air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;
  - .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

- .3 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
  - .4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
  - .5 any other ductwork, casings, plenums or sections specified or detailed on drawings to be insulated – thickness as specified.
- .2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.
  - .3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:
    - .1 at trapeze hanger locations, install insulation between duct and hanger;
    - .2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.
  - .4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.
  - .5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.
  - .6 Insulation application requirements common to all types of rigid ductwork are as follows:
    - .1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;
    - .2 installation of fastener pins and washers is to be concurrent with duct insulation application;

- .3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;
- .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
- .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

### **3.13 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC**

- .1 Insulate exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside building with minimum 40 mm (1-1/2") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 20 mm (3/4") thick layers with staggered tightly butted joints.
- .2 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.

### **3.14 APPLICATION OF INSULATING COATINGS**

- .1 Apply, in accordance with manufacturer's instruction, insulating coatings to following bare metal surfaces:
  - .1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;
  - .2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.
- .2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

### **3.15 INSULATION FINISH REQUIREMENTS**

- .1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.
- .2 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.
- .3 Apply 2 heavy coats of "PITTCOTE 404" coating with 24 hr. between coats to foamed glass insulation exposed above grade.
- .4 Apply 2 coats (with 24 hr. between coats) of specified coating to flexible elastomeric insulation outside building.



END OF SECTION

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies commissioning requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. When requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Divisions 00 or 01 to take precedence.

### **1.02 REFERENCE**

- .1 Refer to commissioning requirements specified in Division 01.

### **1.03 COMMISSIONING AGENT INVOLVEMENT VERSUS WARRANTY OBLIGATIONS**

- .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.

### **1.04 SUBMITTALS**

- .1 Submit to Commissioning Agent, at same time as submittal to Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
- .2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.
- .3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.
- .4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.
- .5 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter confirming pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.

### **1.05 DEFINITIONS**

- .1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, all as further described below.
- .2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned mechanical work.
- .3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm equipment has been properly installed and is operational as intended.

- .4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm components, equipment, systems and/or subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag in accordance with drawings, and, for each commissioning procedure listed, a column giving expected data in accordance with Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.
- .7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.
- .8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

#### **1.06 COMMISSIONING AGENT**

- .1 Retain services of a qualified Commissioning Agent.

#### **1.07 QUALITY ASSURANCE**

- .1 Commissioning work is to be in accordance with requirements of following:
  - .1 CSA Z320, Building Commissioning Standard and Check Sheets;
  - .2 ASHRAE Guideline 0, The Commissioning Process;
  - .3 ASHRAE Guideline 1.1, The HVAC Commissioning Process;
  - .4 Owner designated Commissioning Agent.
- .2 Commissioning Agent is to meet following qualifications:
  - .1 be a member of Professional Engineers Association in Province of the work;
  - .2 be a member of Building Commissioning Association, and a Certified Commissioning Professional (CCP) as designated by Building Commissioning Association;
  - .3 have a minimum of 5 years of successful documented commissioning experience on projects of similar size and complexity as this Project;

- .4 supply a qualified P. Eng. and a Building Commissioning Association Certified Commissioning Professional (CCP) or an ASHRAE Commissioning Project Management Professional (CPMP) on site to supervise commissioning process.

#### **1.08 COMMISSIONING OBJECTIVES**

- .1 Objectives of commissioning process:
  - .1 to support quality management by means of monitoring and checking installation;
  - .2 to verify equipment/system performance by means of commissioning of completed installation;
  - .3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

#### **1.09 TESTING EQUIPMENT**

- .1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

#### **2 PRODUCTS**

Not Used

#### **3 EXECUTION**

##### **3.01 COMMISSIONING**

- .1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent.
- .2 Prerequisites to successful completion of commissioning:
  - .1 submittal of signed start-up and test reports;
  - .2 completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports;
  - .3 permanent electrical and control connections of equipment;
  - .4 successful completion and documentation of pre-functional performance testing;
  - .5 submittal of letters to Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

##### **3.02 DEFICIENCIES LISTED DURING COMMISSIONING**

- .1 Correct deficiencies listed by Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with Consultant, and when deficiencies have been corrected, notify Consultant and Commissioning Agent immediately.

### 3.03 SYSTEMS TO BE COMMISSIONED

- .1 Mechanical systems to be commissioned include, but are not to be limited to, systems described below. Specific commissioning procedures are to be as directed by Commissioning Agent.
- .2 Commissioning of drainage systems includes:
  - .1 commissioning of drainage pumps and controls by means of tests recommended by manufacturer to confirm proper operation and performance;
  - .2 commissioning of equipment such as interceptors and backflow preventers.
- .3 Commissioning of fire protection systems will be considered complete upon preparation and submittal by Contractor of completion certificates required by applicable NFPA Standards, demonstration of proper system operation to local Fire Chief and any other authorities, including Owner's insurance underwriter as required, and coordination and cooperation with fire alarm system commissioning procedures, in particular smoke control systems and other such fan system control sequences.
- .4 Commissioning of water systems (all piping extended from Municipal main) includes:
  - .1 commissioning of pumps and controls;
  - .2 commissioning of water heaters;
  - .3 commissioning of piping specialties such as backflow preventers, mixing valves, and similar components;
  - .4 commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap;
  - .5 commissioning of plumbing fixtures.
- .5 Commissioning of natural gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.1, and any supplemental requirements of governing authorities.
- .6 Perform commissioning of fuel oil system in accordance with requirements of CAN/CSA B139.
- .7 Commissioning of heating systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .8 Commissioning of cooling systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .9 Commissioning of HVAC chemical treatment systems includes feed and monitoring equipment, and testing of system fluids to confirm proper concentration of chemical.

- .10 Commissioning of air handling systems includes equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows in accordance with TAB reports.
- .11 Control work commissioning includes confirmation of proper operation of individual control components, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.
- .12 Commissioning of BAS includes confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.
- .13 Commissioning of noise and vibration control equipment includes noise and vibration measurements to confirm proper operation of equipment.

### **3.04 COMMISSIONING PROCESS**

- .1 Perform commissioning process in stages and include, but not be limited to, following:
  - .1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
  - .2 Stage 2: Commissioning work performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
  - .3 Stage 3: Successful completion of satisfactory equipment/system operation during 1<sup>st</sup> month after issue of a Certificate of Total Performance of the Work.
  - .4 Stage 4: Successful completion of satisfactory equipment/system operation during 3<sup>rd</sup> month after issue of a Certificate of Total Performance of the Work.
  - .5 Stage 5: Successful seasonal commissioning of building.

### **3.05 RESPONSIBILITIES OF COMMISSIONING AGENT**

- .1 During construction phase, Commissioning Agent is to:
  - .1 review Contractor's shop drawings for commissioning related issues, and report any such issues to Consultant;
  - .2 as soon as possible after project start-up, prepare and issue a Commissioning Plan based on Contractor's construction schedule;
  - .3 prior to tests, supply pre-functional performance test commissioning data sheets for equipment and systems to be commissioned to Contractor;
  - .4 monitor and inspect installation on a regular basis throughout construction stages, issue reports identifying any issues which may have an impact on commissioning process, and work with project team to expeditiously resolve any problems that may arise due to site conditions;

- .5 arrange with Contractor for on-site commissioning meetings on an as-required basis, to be attended by Contractor and applicable subcontractors, Owner, and Consultant, chair meetings, and prepare and distribute meeting minutes to attendees;
  - .6 witness and validate tests, identify deficiencies, and issue progress reports;
  - .7 coordinate commissioning scheduling with Contractor;
  - .8 review final TAB report on site with Contractor, and check 100% of TAB results for fan equipment, 30% of TAB results for duct systems outward from fan equipment, and issue a report to Consultant;
  - .9 for smaller multiple items of equipment such as air terminal boxes, fan coil units, backflow preventers, and similar equipment, review completed commissioning data sheets submitted by Contractor and review data sheet information on-site with Contractor for 30% of quantity of each item of equipment;
  - .10 review pre-functional performance test commissioning data sheets submitted by Contractor, then witness and supervise functional performance testing and supervise and direct commissioning process, validate commissioning procedures, witness completion of commissioning data sheets by Contractor, and sign completed data sheets;
  - .11 perform a preliminary review of Contractor's O & M Manuals, before they are issued to Consultant, and issue any comments to Consultant;
  - .12 coordinate, with Contractor and Owner, training and instructions by Contractor and his equipment and system manufacturers/suppliers to Owner's operating and maintenance personnel, and comment on quality of training and instructions to Consultant;
  - .13 prepare and issue Systems Operation Manual to Owner prior to equipment and system training by Contractor.
- .2 During post construction phase, Commissioning Agent is to:
- .1 prepare and issue final report on commissioning, identifying any deficiencies that remain outstanding;
  - .2 recommend any training and/or instructions to be given to Owner's operating and maintenance personnel in addition to training and instructions already given;
  - .3 after Substantial Performance of the Work, witness system checks and validate documentation by Contractor as follows:
    - .1 once during 1<sup>st</sup> month of building operation;
    - .2 once during 3<sup>rd</sup> month of building operation;
    - .3 once between 4<sup>th</sup> and 10<sup>th</sup> month of building operation but during a season opposite to 1<sup>st</sup> or 3<sup>rd</sup> month visits.
  - .4 ensure any deficient work resulting from system checks described above are corrected;

- .5 3 months after Substantial Performance of the Work, attend a question and answer session(s) with Contractor to answer any questions and concerns related to commissioning work from Owner's operating personnel.

### 3.06 RESPONSIBILITIES OF CONTRACTOR

- .1 During construction phase, Contractor is to:
  - .1 prepare and submit an installation schedule which includes a time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates;
  - .2 prepare and submit a commissioning schedule which is to include a time schedule coordinated with installation schedule referred to above and Commissioning Agent, and allowances for additional time for re-tests as may be required, and update schedule on a monthly basis as required;
  - .3 when requested by Commissioning Agent, arrange site commissioning meetings with Owner, Consultant, and applicable subcontractors present, to be chaired by Commissioning Agent who will also prepare and distribute meeting minutes;
  - .4 promptly correct reported deficient work, and report when corrective work is complete;
  - .5 where required by Codes and/or Specification, retain equipment manufacturers/suppliers or independent 3<sup>rd</sup> parties to certify correct installation of equipment/systems;
  - .6 under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor;
  - .7 complete Commissioning Agent's commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit sheets to Commissioning Agent, accompany Commissioning Agent for an on-site check of 30% of data sheet information for each type of equipment, and perform any corrective action required as a result of site checks;
  - .8 perform system testing, adjusting and balancing and, when complete, issue a copy of final report to Commissioning Agent for review and a site check of results, and perform any corrective work required as a result of site checks by Commissioning Agent;
  - .9 in accordance with updated commissioning schedule and actual progress at site, certify in writing to Consultant and Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures, giving Consultant and Commissioning Agent a minimum of 5 working days' notice;



- .10 perform system and subsystem functional performance testing under supervision of Commissioning Agent, and submit to Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.
- .2 During post construction phase, Contractor is to:
  - .1 optimize system operation in accordance with building occupant's needs and comments using System Operation Manual prepared by Commissioning Agent as reference;
  - .2 complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase;
  - .3 accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
    - .1 once during 1<sup>st</sup> month of building operation;
    - .2 once during 3<sup>rd</sup> month of building operation;
    - .3 once between 4<sup>th</sup> and 10<sup>th</sup> months in a season opposite to 1<sup>st</sup> and 3<sup>rd</sup> month visits.
  - .4 correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work;
  - .5 3 months after Substantial Completion conduct a question and answer session(s) at building with Owner's operating and maintenance personnel, with duration of session(s) dictated by number of questions and concerns that have to be addressed.

**END OF SECTION**

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### **1.02 DEFINITIONS**

- .1 “Agency” – means agency to perform testing, adjusting and balancing work.
- .2 “TAB” – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.
- .3 “hydronic systems” – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
- .4 “air systems” – includes outside air, supply air, return air, exhaust air, and relief air systems.
- .5 “flow rate tolerance” – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.
- .6 “report forms” – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting and balancing.
- .7 “terminal” – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .8 “main” – means duct or pipe containing system’s major or entire fluid flow.
- .9 “submain” – means duct or pipe containing part of the systems’ capacity and serving 2 or more branch mains.
- .10 “branch main” – means duct or pipe servicing 2 or more terminals.
- .11 “branch” – means duct or pipe serving a single terminal.

### **1.03 SUBMITTALS**

- .1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.
- .2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.

- .3 Submit a report by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.
- .4 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.
- .5 Submit a draft report, as specified in Part 3 of this Section.
- .6 Submit a final report, as specified in Part 3 of this Section.
- .7 Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .8 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

#### **1.04 QUALITY ASSURANCE**

- .1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
  - .1 AABC - Associated Air Balance Council;
  - .2 NEBB - National Environmental Balancing Bureau.
- .2 Testing, adjusting and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with 1 of following publications:
  - .1 National Standards for a Total System Balance published by Associated Air Balance Council;
  - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
  - .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

#### **2 PRODUCTS**

Not Used

#### **3 EXECUTION**

##### **3.01 SCOPE OF WORK**

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.
- .2 Mechanical systems to be tested, adjusted and balanced include:

- .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
  - .1 domestic hot water recirculation piping;
  - .2 tempered water piping flows.
- .2 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .3 TAB of cooling systems is also to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine".
- .4 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities and flows.

### **3.02 TESTING, ADJUSTING AND BALANCING**

- .1 Conform to following requirements:
  - .1 as soon as possible after award of Contract, Agency is to carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
  - .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
  - .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;
  - .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
  - .5 testing, adjusting and balancing is not to begin until:
    - .1 building construction work is substantially complete and doors have been installed;
    - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
  - .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
  - .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;

- .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
  - .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
  - .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
  - .11 for belt-driven equipment, Agency is to report to Commissioning Agent who in turn is to inform Contractor and Consultant of any situation where sheaves have to be replaced to suit testing and balancing, and replacements are to be done by Contractor at no cost;
  - .12 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
  - .13 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
  - .14 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of  $\pm 5\%$  of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
  - .15 Agency is to perform testing, adjusting and balancing to within  $\pm 5\%$  of design values, and make and record measurements which are within  $\pm 2\%$  of actual values;
  - .16 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
  - .17 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within  $2.8^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ) wet bulb temperature of maximum summer design condition, and within  $5.5^{\circ}\text{C}$  ( $10^{\circ}\text{C}$ ) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 Prepare reports as indicated below.
    - .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

- .2 Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on Project Documents.
- .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, 3-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into divisions listed below, separated by divider tabs:
  - .1 General Information and Summary;
  - .2 Air Systems;
  - .3 Hydronic Systems;
  - .4 Temperature Control Systems;
  - .5 Special Systems.
- .4 Agency is to provide following minimum information, forms and data in report:
  - .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;
  - .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
  - .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
  - .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
- .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.
- .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.

- .5 After acceptance of final report, Agency is to perform post testing and balancing site visits in accordance with following requirements:
  - .1 post testing and balancing site visits are to be made:
    - .1 once during first month of building operation;
    - .2 once during third month of building operation;
    - .3 once between fourth and tenth months in a season opposite to first and third month visit.
  - .2 during each return visit and accompanied by Owner's representative, Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;
  - .3 Agency is to schedule each visit with Contractor and Owner, and inform Consultant;
  - .4 after each follow-up site visit, Agency is to issue to Contractor and Consultant a report indicating any corrective work performed during visit, abnormal conditions and complaints encountered, and recommended corrective action.

**END OF SECTION**

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies material requirements for firestopping and smoke seal systems that are common to mechanical work Sections and it is a supplement to each Section and is to be read accordingly.

### **1.02 SUBMITTALS**

- .1 At least 4 weeks prior to work commencing, submit a sample of each type of material requirements for firestop and smoke seal systems in applied form. Identify each system with manufacturer's name and type, ULC designation, and proposed use. After samples are reviewed, work is to conform to reviewed samples.
- .2 Submit a product data sheet and WHIMIS sheet for each firestopping and smoke seal product.
- .3 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.
- .4 Submit letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

### **1.03 QUALITY ASSURANCE**

- .1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and applicator's qualifications are to be submitted to Consultant for review.
- .2 Comply with firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

## **2 PRODUCTS**

### **2.01 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS**

- .1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC S115, and CAN/ULC S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.
- .2 Firestopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.



- .4 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .5 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.
- .6 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" re-enterable, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- .7 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.
- .8 Supply products of a single manufacturer for use on work of this Division.
- .9 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .10 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .11 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .12 Acceptable manufacturers are:
  - .1 Specified Technologies Inc.;
  - .2 3M Canada Inc.;
  - .3 Tremco;
  - .4 A/D Fire Protection Systems;
  - .5 Nelson;
  - .6 Hilti Canada.

### 3 EXECUTION

#### 3.01 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire rated construction, provide ULC certified, listed and labelled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to ensure that continuity and integrity of fire separation is maintained. Openings not in immediate vicinity of working areas are to be firestopped and sealed same day as being opened.
- .2 Install firestopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and manufacturer's instructions. Comply with local governing building code requirements and obtain approvals from local building inspection department. Ensure that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and firestopping materials.
- .3 Ensure that continuity and integrity of fire separation is maintained and conform to requirements of latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".
- .4 Comply with following requirements:
  - .1 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.
  - .2 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
  - .3 Report any unsuitable or unsatisfactory conditions to Consultant in writing, prior to commencement of work. Commencement of work will mean acceptance of conditions and surfaces.
  - .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.
  - .5 Prime substrates in accordance with product manufacturer's written instructions.
  - .6 Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.
  - .7 Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.
  - .8 Remove excess compound promptly as work progresses and upon completion.
  - .9 At fusible link damper locations, seal perimeter of angle iron framing on both sides of wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.
- .5 Notify Consultant when work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of work by local governing authority inspector prior to concealing or enclosing work. Make any corrections required.

- .6 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to service penetrations and that installation has been performed in strict accordance with requirements of local governing building code, any applicable local municipal codes, ULC requirements, and manufacturer's instructions.
- .7 Manufacturer's authorized representative to inspect and verify each installation and provide a test report signed by installing trade and manufacturer's representative. Test report to list each installation and respective ULC certification and number.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets to regulatory authority for review and approval prior to submitting to Consultant. Conform to following requirements:
  - .1 submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;
  - .2 submit complete CAD layout drawings indicating source of water supply with test flow and pressure, "head-end" equipment piping schematic, pipe routing and sizing, and zones, all signed and sealed by a qualified professional mechanical engineer registered in jurisdiction of the work as specified below;
  - .3 submit copies of all calculations, including hydraulic calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements;
  - .4 in addition to submitting shop drawings to regulatory authority as specified above, shop drawings must be approved by Owner's insurer prior to being submitted to Consultant for review.
- .2 Submit a complete sprinkler system test certificate as specified in Part 3 of this Section.
- .3 Sprinklers are to be identified on drawings and product submittals, and be specifically identified by manufacturer's listed model or series designation. Trade names and other abbreviated listings are unacceptable.

**1.02 QUALITY ASSURANCE**

- .1 Fire protection sprinkler system work is to be in accordance with following Codes and Standards:
  - .1 NFPA 13, Standard for the Installation of Sprinkler Systems;
  - .2 CSA B137.2, Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications;
  - .3 CSA B137.3, Rigid Polyvinylchloride (PVC) Pipe for Pressure Applications;
  - .4 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless;
  - .5 ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe;
  - .6 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;
  - .7 ASTM A536, Standard Specification for Ductile Castings;
  - .8 ASTM A795, Standard Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use;

- .9 ANSI/ASME B16.4, Grey Iron Threaded Fittings (Classes 125 and 250);
- .10 CAN/CSA B64.10, Backflow Preventers and Vacuum Breakers.
- .2 Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. Site personnel are to be licensed in jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter licensed in jurisdiction of the work.
- .3 Check and verify dimensions and conditions at site and ensure work can be performed as indicated. Coordinate work with trades at site and accept responsibility for and cost of making adjustments to piping and/or spacing to avoid interference with other building components.
- .4 System components must be ULC listed and labelled.
- .5 Grooved couplings, and fittings, valves and specialties are to be products of a single manufacturer. Grooving tools are to be of same manufacturer as grooved components.
- .6 Castings used for coupling housings, fittings, valve bodies, etc., are to be date stamped for quality assurance and traceability.

### **1.03 DESIGN REQUIREMENTS**

- .1 Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards, and, where required, local building and fire department requirements and standards of Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at nearest fire hydrant to obtain criteria to be used in system design. Include hydrant location and flow and pressure test data with system design calculations.
- .2 Include for a qualified mechanical professional engineer registered and licensed in the jurisdiction of the work to design the fire protection standpipe work. Refer to Section entitled Mechanical Work General Instructions for requirements regarding Contractor retained engineers.
- .3 Sprinkler /System Occupancy – Hazard Design requirements: In accordance with NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

## **2 PRODUCTS**

### **2.01 PIPE, FITTINGS AND JOINTS**

- .1 Pipe, fittings and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
  - .1 PVC
    - .1 Class 200, DR14, rigid, hub and spigot pattern PVC pipe and CSA certified fittings to CAN/CSA B137.2 and B137.3 and complete with gasketed joints.
  - .2 Schedule 40 Steel – Grooved Coupling Joints

- .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.
- .3 Schedule 40 Steel – Screwed and Welded Joints
  - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.
- .4 Schedule 10 Steel – Grooved Coupling Joints
  - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints.
- .5 Schedule 10 Steel – Screwed Joints
  - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with mill or site threaded ends, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
- .6 "Lightwall" Steel – Grooved Coupling Joints
  - .1 Commercial quality. "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, complete with a galvanized exterior, grooved ends, and fittings and couplings equal to Victaulic "Fire Lock" grooved fittings and Victaulic Style 009N QuickVic or 005 rigid coupling joints.
- .7 "Lightwall" Steel – Screwed Joints
  - .1 Commercial quality, "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, ULC listed, mill or site threaded, complete with galvanized exterior, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
- .8 Flexible Pipe – Equal to Victaulic "VicFlex"
  - .1 Drop system is to consist of a braided type 304 stainless steel flexible tube, zinc plated steel 25 mm (1") NPT male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 12 mm (1/2") or 20 mm (3/4") NPT female thread for connection to sprinkler head.
  - .2 Drop is to include a cULus/FM approved Series AH2 braided hose with a bend radius to 50 mm (2") to allow for proper installation in confined spaces.
  - .3 Hose is to be listed for following number of 50 mm (2") radius 90° bends:
    - .1 4 bends at 0.79 m (31") length;
    - .2 5 bends at 0.91 m (36") length;
    - .3 8 bends at 1.2 m (48") length;

- .4 10 bends at 1.5 m (60") length;
- .5 12 bends at 1.8 m (72") length.
- .4 Union joints are to be provided for ease of installation, prevention of hose torque stresses and on site changing of factory 146 mm (5.75") straight reducing nipple in reduced spaces under obstructions.
- .5 On T-bar ceiling grid with drop in tile application, flexible drop is to attach to ceiling grid using a one-piece open gate Series AB1 bracket. Bracket is to allow installation before ceiling tile is in place.
- .6 On T-bar ceiling grid designed for hard lid drywall application, flexible drop is to attach to ceiling grid using a one-piece open gate Series AB2 bracket. Bracket is to allow for vertical adjustment of reducer/head from below drywall, post-drywall installation.
- .7 On hat furring channel grid with hard lid drywall application, flexible drop is to attach to ceiling grid using a one-piece open gate Series AB4 bracket. Bracket is to allow for vertical adjustment of reducer/head from below drywall, post-drywall installation.
- .8 Braided drop system is to be cULus listed for sprinkler services to 1206 kPa (175 psi).
- .9 Standard Mechanical Couplings: Equal to Victaulic
  - .1 Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets are to be pressure-responsive synthetic rubber, grade to suit intended service, conforming to ASTM D-2000. Mechanical coupling bolts are to be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings are to comply with ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
  - .2 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads are to be used to provide system rigidity and support and hanging in accordance NFPA-13. Couplings are to be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted.
  - .3 Flexible Type: Use in locations where vibration attenuation and stress relief are required; Victaulic Style 177 (Quick-Vic™) flexible coupling.

## 2.02 SERVICE MAIN DOUBLE CHECK VALVE ASSEMBLY

- .1 Minimum 1205 kPa (175 psi) rated dual check valve backflow preventer assembly to CAN/CSA B64, complete with tight-closing resilient seated shut-off valves, test cocks and strainer.
- .2 Acceptable manufacturers are:
  - .1 Watts Industries Canada;
  - .2 Zurn/Wilkins;

### 2.03 SHUT-OFF VALVES

- .1 Minimum 2070 kPa (300 psi) rated full port brass or bronze body screwed ball valves and lug body or grooved end type butterfly valves.
  - .1 Butterfly valves are to include a pressure responsive seat, and stem is to be offset from disc centerline to provide complete 360° circumferential seating.
  - .2 Standard of Acceptance: Victaulic Style 705.
  - .3 Supervised closed applications standard of acceptance Victaulic Series 707C supervised closed butterfly valve.
- .2 OS&Y Gate Valves: 1725 kPa (250 psi), grooved ends with ductile iron body, yoke, and handwheel conforming to ASTM A-536, EPDM coated ASTM A-126-B cast iron disc, ASTM B16 brass rising stem, flanged and epoxy coated ductile iron bonnet, EPDM O-ring stem seals and body gasket. Equal to Victaulic Series 771H (Grooved ends) and Series 771F (Grooved x Flanged).

### 2.04 CHECK VALVES

- .1 Minimum 1725 kPa (250 psi) resilient seat check valves, suitable for vertical or horizontal installations. Standard of Acceptance: Victaulic Series 717.
- .2 Check valves associated with Fire Department connections and fire pump test connection are to be tapped for site installation of a 20 mm ( $\frac{3}{4}$ " ) diameter ball drip.

### 2.05 BALL DRIPS

- .1 Equal to National Fire Equipment Ltd. Model #A58, 20 mm ( $\frac{3}{4}$ " ) diameter automatic ball drip.

### 2.06 SHUT-OFF VALVE SUPERVISORY SWITCHES

- .1 Tamper-proof supervisory switches, each arranged to activate a fire alarm system trouble alarm condition if the valve is closed or tampered with, each suitable in all respects for the application, and each complete with all required mounting and connection hardware.
- .2 Actuator housings are to be weatherproof.

### 2.07 FIRE DEPARTMENT CONNECTION

- .1 Wall mounting polished brass clapper type dual inlet Fire Department connection with 2, 65 mm (2- $\frac{1}{2}$ " ) diameter inlets threaded to Fire Department hose requirements and equipped with caps and chains, an outlet sized as shown, and a faceplate.
- .2 Faceplate is to be polished brass and complete with "AUTO-SPKR" cast-in raised lettering.
- .3 Exposed metal parts of Fire Department connection are to be chrome plated.
- .4 For low point near each fire department connection, a 90° elbow with drain connection to allow for system drainage to prevent freezing. Standard of Acceptance: Victaulic #10-DR.

### 2.08 SPRINKLER MAIN "LOSS OF PRESSURE" ALARM SENSOR



- .1 Piping mounted adjustable pressure sensor designed to actuate an alarm upon sensing a loss of pressure in the fire protection main. Switch is to be low voltage or line voltage as required.

## **2.09 WATER FLOW ALARM SWITCH**

- .1 Pipe mounting water flow alarm switch, minimum 1725 kPa (250 psi) rated, designed to actuate 2, 7 ampere rated (at 125/250 VAC) SPDT snap action switches when water flow exceeds 0.758 L/sec. (10 Imperial gpm), complete with a tamper-proof cover with conduit connection opening, a piping saddle and U-bolt, and an automatic reset pneumatic retard device with field adjustable (0 to 70 second) switch actuation delay to reduce false alarms caused by a single or series of transient water flow surges.

## **2.10 WATER MOTOR ALARM**

- .1 Surface wall mounting water motor driven alarm device consisting of a water motor assembly with 20 mm (¾") diameter inlet and 25 mm (1") or 32 mm (1-¼") diameter drain connections, inlet strainer, a red enamelled steel exterior wall mounting strike and gong assembly, a drive shaft sleeve with drive shaft to connect water motor and gong assembly and, at the exterior gong, identification to read "SPRINKLER FIRE ALARM - WHEN BELL RINGS CALL FIRE DEPARTMENT OR POLICE".

## **2.11 DRY PIPE VALVE**

- .1 Equal to a Victaulic Series 768-NXT:
  - .1 Series 746-LPA accelerator quick opening device;
  - .2 Series 757 regulated air maintenance trim assembly;
  - .3 required air pressure: 90 kPa (13 psig);
  - .4 externally resettable valve;
  - .5 Series 757 regulated air maintenance trim assembly.
- .2 Valve to be complete with internal components that are replaceable without removing valve from installed position.
- .3 Systems requiring a quick opening device are to use a regulated, tank mounted air supply.

## **2.12 DRY PIPE ZONE AIR COMPRESSOR**

- .1 Equal to Victaulic 7C7, CSA certified, oil-less, piston type direct driven compressor with a motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, and a mounting bracket.
- .2 Compressor set capacity and performance must suit final dry pipe system design and reviewed piping and sprinkler head layout shop drawings. If a larger compressor set than that specified is required, provide larger set at no additional cost, and include any additional costs for a larger size motor starter and associated wiring.

## **2.13 ZONE CONTROL RISER MODULES**

- .1 Equal to Victaulic Co. "FireLock" Series 747M factory assembled zone control riser modules, each complete with a painted cast ductile iron grooved end body, a ball type shut-off valve, a test and drain combination with properly sized orifice, a flow alarm switch, a pressure gauge with cock, and a pressure relief valve kit.

## **2.14 SPRINKLER HEADS**

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Sprinkler body is to be die-cast, with a hex-shaped wrench boss integrally cast into sprinkler body to reduce risk of damage during installation. Wrenches are to be provided by sprinkler manufacturer that directly engages wrench boss.
- .3 For locations where corrosive resistant coatings are required, body is to be coated with ULC listed and FM approved anti-corrosion VC-250 coating (silver colouring).
- .4 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match ceiling colour.
- .5 Where exposed pendent heads occurs in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.
- .6 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .7 Escutcheons and guards are to be listed, supplied, and approved for use with sprinkler by sprinkler manufacturer.
- .8 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 74°C (165°F) heads. All other heads, unless otherwise specified or required, are to be 57°C (135°F) rated.
- .9 Acceptable manufacturers are:
  - .1 Victaulic Co.;
  - .2 Tyco Fire Suppression & Building Products;
  - .3 The Viking Corporation;
  - .4 The Reliable Automatic Sprinkler Co.

## **2.15 SPARE SPRINKLER HEAD CABINET**

- .1 Surface wall mounting, red enamelled steel, identified cabinet with hinged door, shelves with holes for mounting sprinkler heads, a wrench or wrenches suitable for each type of sprinkler head, and a full complement of spare sprinkler heads.
- .2 Cabinet is to be sized to accommodate a minimum of 4 spare heads for each type of head used on the project, however, each cabinet is to be full of spare heads.

## **3 EXECUTION**

- .1 Provide required sprinkler system piping.
- .2 Perform piping work in accordance with requirements of NFPA 13, governing regulations, and "Reviewed" shop drawings.
- .3 Piping, unless otherwise specified, is as follows:
  - .1 for piping inside building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2-½") diameter and larger, welding fittings and welded joints;
  - .2 for wet system piping inside building and above ground – at your option, CPVC sprinkler pipe and fittings;
  - .3 for piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 or "Lightwall" black steel pipe with Victaulic or equal fittings and coupling joints or screwed fittings and joints;
  - .4 for branch piping to heads in suspended ceilings, etc. – at your option, flexible piping installed in accordance with manufacturer's instructions;
  - .5 for branch piping to heads in MRI suites – copper pipe, fittings, and sprinkler head adapters with stainless steel hangers and support hardware.
- .4 Exceptions to piping requirements specified above are as follows:
  - .1 dry pipe zone steel piping, fittings, unions, couplings and flanges are to be galvanized;
  - .2 wet zone steel piping, fittings, unions, couplings and flanges for sprinkler work exposed to weather either inside or outside building (including parking garages), are to be galvanized;
  - .3 PVC piping is not to be used above grade;
  - .4 ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.
- .5 Pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on drawings are to assist during tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce size of sprinkler main or re-route main unless reviewed with and approved by Consultant.
- .6 Install grooved joints in accordance with manufacturer's latest installation instructions. Grooved ends are to be clean and free from indentations, projections and roll marks. Gaskets are to be moulded and produced by coupling manufacturer, and verified as suitable for intended service. Have factory-trained representative from mechanical joint manufacturer provide on-site training in proper use of grooving tools and installation of grooved piping products. Have factory-trained representative periodically review product installation and ensure best practices are being followed. Remove and replace any improperly installed products.

- .7 Clean pipe, fittings, couplings, flanges and similar components after erection is complete. Wire brush clean any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibit rust and carefully coat with suitably coloured primer.
- .8 When sprinkler work is complete, test system components and overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.

### **3.02 INSTALLATION OF DOUBLE CHECK VALVE ASSEMBLY**

- .1 Provide a double check valve assembly in sprinkler main inside the building.
- .2 Equip assembly with inlet and outlet shut-off valves with supervisory switches as specified below.
- .3 Support each end of assembly from floor by means of flanged pipe supports with saddles.

### **3.03 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES**

- .1 Provide shut-off valves and check valves in piping where shown and wherever else required.
- .2 Locate valves for easy operation and maintenance.
- .3 Confirm exact locations prior to roughing-in.

### **3.04 INSTALLATION OF SHUT-OFF VALVE SUPERVISORY SWITCHES**

- .1 Equip each shut-off valve with a supervisory switch.
- .2 Identify each supervised valve with a 150 mm (6") square, engraved, laminated red-white plastic tag to correspond with supervised valve numbering specified and/or shown as part of the electrical work fire alarm system.
- .3 At low point near each fire department connection, install a 90° elbow with drain connection to allow for system drainage to prevent freezing.

### **3.05 INSTALLATION OF FIRE DEPARTMENT CONNECTION**

- .1 Provide an exterior Fire Department connection. Confirm exact location prior to roughing-in. Confirm finish prior to ordering.
- .2 Equip connection with a check valve. Equip check valve with a ball drip to drain piping between Fire Department connection and check valve, and extend drainage piping from outlet of ball drip to nearest suitable floor drain.

### **3.06 INSTALLATION OF LOSS OF PRESSURE SENSOR**

- .1 Supply and mount a pressure sensor in the fire protection piping main to activate a "LOSS OF PRESSURE" trouble alarm should Municipal water service pressure fall below the acceptable level.
- .2 Locate sensor for easy access and maintenance, and set alarm pressure to suit site conditions. Confirm setting on site.

- .3 Identify pressure sensor and its normal setting with a 150 mm (6") square red-white laminated plastic tag engraved to read "LOSS OF WATER PRESSURE SENSOR - NORMAL SETTING 210 kPa". Confirm wording prior to engraving.

### **3.07 INSTALLATION OF FLOW ALARM SWITCHES**

- .1 Provide water flow alarm switches in accessible locations in zone piping.
- .2 Adjust to suit site water pressure conditions. Check and test operation.
- .3 Identify each switch with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

### **3.08 INSTALLATION OF DRY PIPE VALVES**

- .1 Provide dry pipe valves for zones.
- .2 Connect compressed air piping to each valve, as well as all compressed air piping trim.
- .3 When installation is complete, check and test valve operation and adjust as required.
- .4 Provide drum drips in dry type fire protection sprinkler zone piping where shown or required. Wherever possible locate drum drips in heated areas. Where drum drips are located in unheated areas ensure trades performing thermal insulation work and electric heating cable pipe tracing work are aware of the number of drum drips required, and the size and location. Identify each drum drip. Locate drum drips in heated areas wherever possible.

### **3.09 INSTALLATION OF DRY ZONE AIR COMPRESSOR**

- .1 Provide an air compressor with air maintenance device and pressure control for the dry pipe zone and dry pipe valve. Secure compressor to a piping main by means of a mounting bracket supplied with compressor. Adjust to suit site conditions.
- .2 Provide an air compressor set with receiver and secure in place on rubber-steel-rubber vibration isolation pads on a concrete housekeeping pad.
- .3 Install flexible piping connections supplied loose with set.
- .4 Extend valved drain piping from receiver to a floor drain.
- .5 Connect receiver and control panel pressure switch with copper tubing.
- .6 When installation is complete, check and test air compressor set, including automatic operation, and adjust as required.

### **3.10 INSTALLATION OF ZONE CONTROL RISER MODULES**

- .1 Provide zone control riser modules with drain piping where required. Terminate drainage piping over a funnel floor drain unless otherwise shown or specified. Identify each assembly.

### **3.11 INSTALLATION OF ZONE CONTROL RISER MODULE CABINETS**

- .1 Provide flush wall mounting cabinets for zone control and inspector's test connection assemblies where required in finished areas. Confirm exact locations prior to roughing-in.
- .2 Identify each cabinet with a nameplate in accordance with requirements of Section entitled Basic Mechanical Materials and Methods.

**3.12 INSTALLATION OF SPRINKLER HEADS**

- .1 Provide required sprinkler heads in accordance with following schedule:

APPLICATION	SPRINKLER HEAD TYPE
Rooms/areas with a suspended ceiling	Victaulic V38/V39 or Tyco Series RFII "Royal Flush II" concealed pendent Victaulic V27 or Tyco Series TY-FRB recessed pendent Victaulic V27 or Tyco Series TY-FRB pendent with escutcheon plates
Rooms/areas without a suspended ceiling	Victaulic V27 or Tyco Series TY-FRB upright
Unheated and unfinished areas	Victaulic V36 or Tyco Series DS-3 ECOH dry horizontal sidewall in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping

- .2 Sprinkler head manufacturers indicated on schedule are for type indication purposes. Acceptable manufacturers are listed in Part 2 of this Section.
- .3 Coordinate sprinkler head locations with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.
- .4 Maintain maximum headroom in areas with no ceilings.
- .5 Provide guards for heads where they are subject to damage.
- .6 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

**3.13 INSTALLATION OF SPARE SPRINKLER HEAD CABINET**

- .1 Supply a full complement (to fill cabinet) of spare sprinkler heads of types used (minimum 4 of each type) and place in a wall mounting storage cabinet located adjacent to sprinkler system "head end" equipment where later directed.

**3.14 INSTALLATION OF INDICATOR POST VALVE**

- .1 Provide a shut-off valve in underground sprinkler main piping outside building. Equip valve with a valve box and an indicator post assembly.

- .2 Confirm valve box length and steel shaft length prior to ordering and confirm exact location prior to roughing-in.
- .3 When installation is complete, check and test operation of assembly and adjust as required.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit product data sheets for all products specified in this Section.

**1.02 QUALITY ASSURANCE**

- .1 Fire extinguishers are to be in accordance with following Codes and Standards:
  - .1 National Fire Code of Canada;
  - .2 NFPA 10, Standard for Portable Fire Extinguishers;
  - .3 CAN/ULC S508, Standard for the Rating and Testing of Fire Extinguishers.

**2 PRODUCTS**

**2.01 GENERAL**

- .1 Fire extinguishers are to be pressurized (stored pressure) rechargeable type, in accordance with NFPA 10, and UL and/or ULC listed and labelled for the class of fires and hazard locations for which they are specified.
- .2 Each extinguisher is to be complete with:
  - .1 manufacturer's identification label indicating extinguisher model number, rating, and operating instructions;
  - .2 anodized aluminum or chrome plated forged brass valve with positive squeeze grip on-off operation and a pull-pin safety lock;
  - .3 discharge hose with nozzle or horn and hose securing clip;
  - .4 for wall mounting extinguishers, a wall mounting bracket.

**2.02 3A10B:C RATED DRY CHEMICAL EXTINGUISHERS**

- .1 Multi-purpose 3A10B:C dry chemical extinguishers are to be 100 mm (4") dia., 2.27 kg (5 lb.), each complete with a steel cylinder with a safety red baked enamel finish and a waterproof stainless steel pressure gauge.

**2.03 FIRE EXTINGUISHER CABINETS**

- .1 Surface Mounted: Rectangular break-glass type enclosures sized to suit the extinguishers to be housed, constructed of #18 gauge corrosion resistant steel with a baked white enamel finish, front glass panel, break-glass mechanism, and keyed alike cylinder lock.
- .2 Recessed: Rectangular cabinets sized to suit the extinguishers to be housed, with a #18 gauge corrosion resistant white enamelled steel tub, #14 gauge cleaned and prime coat painted steel door and adjustable trim assembly with rounded corners, semi-concealed piano hinge, safety glass panel, and flush stainless steel door latch.



### **3 EXECUTION**

#### **3.01 INSTALLATION OF FIRE EXTINGUISHERS**

- .1 Provide fire extinguishers of type(s) in accordance with requirements of NFPA 10.
- .2 Unless otherwise shown or specified, wall mount extinguishers using wall brackets supplied with extinguishers.
- .3 Do not install extinguishers until after wall finishing work is complete.
- .4 Be responsible for maintaining fire extinguishers until Substantial Completion of the Work.
- .5 If extinguishers are indicated adjacent to a door, locate extinguishers at the strike side of the door.

#### **3.02 INSTALLATION OF FIRE EXTINGUISHER CABINETS**

- .1 Provide wall cabinets for fire extinguishers where required.
- .2 Unless otherwise shown or specified, locate cabinets so centerline is approximately 1.2 m (4') above finished floor.
- .3 Confirm exact locations prior to installation.

#### **3.03 INSTALLATION OF FIRE BLANKETS**

- .1 Provide fire blankets in wall mounted cabinets in the Kitchen. Confirm exact locations prior to installation.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine.
- .2 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.
- .3 Prior application for Substantial Performance of the Work, submit a minimum of 3 identified keys for key operated hydrants.
- .4 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.
- .5 Submit anchor drawing(s) to detail fabrication and installation of water piping anchors. Drawing(s) are to be prepared and stamped by a professional structural engineer registered and licensed in jurisdiction of the work.
- .6 As specified in Part 3 of this Section, submit a letter from anchor design engineer stating anchor installation has been examined at site and anchors are properly fabricated and installed.

**1.02 QUALITY ASSURANCE**

- .1 Domestic water piping and valves are to comply with following codes, regulations and standards (as applicable):
  - .1 applicable local codes and regulations;
  - .2 ASTM F1960, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing;
  - .3 CAN/CSA B125.1, Plumbing Supply Fittings;
  - .4 CAN/CSA B125.3, Plumbing Fittings;
  - .5 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;
  - .6 CAN/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies;
  - .7 CAN/ULC S101, Fire Endurance Tests of Building Construction and Materials;
  - .8 NSF/ANSI 14, Plastics Piping System Components and Related Materials;
  - .9 NSF/ANSI 61, Drinking Water System Components – Health Effects;
  - .10 NSF/ANSI 372, Drinking Water System Components – Lead Content.

## 2 PRODUCTS

### 2.01 PIPE, FITTINGS AND JOINTS

#### .1 PVC

- .1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars as per Part 3 of this Section.

#### .2 Soft Copper

- .1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

#### .3 Stainless Steel

- .1 Schedule 10S type 304 stainless steel, ASTM A312, factory or site roll grooved, complete with Victaulic or equal type 304 stainless steel roll grooved end fittings and, unless otherwise specified, Victaulic Style 489 or equal lightweight rigid type 304L stainless steel couplings and coupling gaskets equal to Victaulic Grade E or Grade M.

#### .4 Hard Copper - Solder Joint

- .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin/ 5% Antimony or "SILVABRITE 100" solder for other services.

#### .5 Copper Pressure Coupled Joint

- .1 Type "L" hard drawn seamless copper to ASTM B88 with Viega "ProPress with Smart Connect feature" copper fittings with EDPM seals, and pressure type crimped joints made by use of manufacturer recommended tool.

#### .6 Semi-Rigid Polyethylene Tubing

- .1 Versa Fittings and Mfg. Inc. 12 mm (1/2") dia., high density, semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.

#### .7 Flexible Polyethylene

- .1 Flexible polyethylene pipe to CAN/CSA B137.1, 690 kPa (100 psi) rated, complete with insertion type fittings secured with Series 300 stainless steel gear type clamps.

### 2.02 SHUT-OFF VALVES

#### .1 Ball Valves

- .1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 5049A-LF;
  - .2 Milwaukee Valve Co. #UPBA485B;
  - .3 Kitz Corporation Code 859;
  - .4 Apollo Valves #77LF-200;
  - .5 Watts Industries (Canada) Inc. #LFFBVS-3C.
- .2 Butterfly Valves - Flanged Joint
  - .1 Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with valve in position and either side of connecting piping removed. Butterfly valves to and including 100 mm (4") dia. are to be equipped with lever handles. Butterfly valves larger than 100 mm (4") dia. are to be equipped with worm gear operators.
  - .2 Acceptable products are:
    - .1 DeZurik #632L Series;
    - .2 Kitz Corporation Code #6122EL/EG;
    - .3 Toyo Valve Co. #918BESL/EG;
    - .4 Bray Valve and Controls Canada Series 31;
    - .5 Apollo Valves #141 Series;
    - .6 Watts Industries (Canada) Inc. #BF-03.

## 2.03 CHECK VALVES

- .1 Horizontal
  - .1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
  - .2 Acceptable products are:
    - .1 Toyo Valve Co. Fig. 237A-LF;
    - .2 Milwaukee Valve Co. #UP1509;

- .3 Kitz Corporation Code 823;
- .4 Apollo Valves #61LF Series.
- .2 Vertical
  - .1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

#### **2.04 DRAIN VALVES**

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm ( $\frac{3}{4}$ " ) dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm ( $\frac{3}{4}$ " ) dia. garden hose, and a cap and chain.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 5046;
  - .2 Dahl Brothers Canada Ltd. Fig. No. 50. 430;
  - .3 Kitz Corporation Code 58CC;
  - .4 Apollo Valves #78-104-01;
  - .5 Watts Industries (Canada) Inc. #B6000.

#### **2.05 DOMESTIC HOT WATER PIPING BALANCING VALVES**

- .1 Solder or flanged end type as required, globe style, non-ferrous circuit balancing valves designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, and valved ports for connection to a differential pressure meter.
- .2 Acceptable products are:
  - .1 S.A. Armstrong Model CBV Series;
  - .2 Tour and Andersson Model TBV Series;
  - .3 Watts Industries (Canada) Inc. Model CSM Series.

#### **2.06 PARTITION STOPS**

- .1 Equal to Dahl Brothers Canada Ltd. Fig. E2300 Series or equal lead-free partition stops with EDPM packing, slotted spindles, extension tubes, stainless steel access plates, and 3 identified keys.

#### **2.07 DOMESTIC HOT WATER THERMOSTATIC MIXING VALVES**

- .1 Lawler Manufacturing Co. Inc. 800 Series "High-Low Thermostatic Mixer" factory assembled rough bronze thermostatic mixing valve assembly complete with rotatable union end inlet piping with check stops and stainless steel strainer screens, union outlet piping with thermometer connection, all sized as shown, and following:

- .1 mixing valve with liquid motor, stainless steel piston and liner, tamper-resistant control adjustment, and 3-way protection against runaway temperatures, thermal shock, and scalding;
  - .2 dial type thermometer conforming to requirement specified in Section entitled Basic Mechanical Materials and Methods;
  - .3 ball type outlet shut-off valve conforming to valve requirements specified in this Section;
  - .4 surface wall mounting enamelled steel cabinet with hinged door, key lock, and permanent identification;
  - .5 recessed wall mounting type 304 stainless steel cabinet with a #4 finish, hinged door, key lock, and permanent identification.
- .2 Acceptable manufacturers are:
- .1 Lawler Manufacturing Co. Inc.;
  - .2 Leonard Valve Co.;
  - .3 Symmons Industries Inc.

## **2.08 CHLORINE**

- .1 Sodium hypochlorite to AWWA B300.

## **2.09 WATER METER**

- .1 Equal to Neptune Technology Group (Canada) Ltd. "Neptune T-10" tamper-proof, in line serviceable meter in accordance with requirements of AWWA C701 and NSF/ANSI 61, suitable for connection of a remote automatic reading and billing unit and complete with a cast bronze main case, a roll sealed register, and a positive displacement mutating disc measuring chamber.

## **2.10 INTERIOR HOSE BIBBS**

- .1 Flush-Concealed
  - .1 Recessed, 92 mm (3-5/8") deep, recessed, encased wall hydrant with lockable bronze or stainless steel box with hinged cover identified "WATER", bronze interior parts, a screwdriver operated stop in the supply, key operated control valve, 20 mm (3/4") dia. hose connection, and a vacuum breaker.
  - .2 Acceptable products are:
    - .1 Watts Industries (Canada) Inc. #HY-330;
    - .2 Jay R. Smith #5509QT-CL-SAP;
    - .3 Zurn #Z1350;
    - .4 Mifab #MHY-55.

- .2 Semi-Recessed - Finished Areas
  - .1 Anti-siphon type, 100 mm (4") deep hose bibb with stainless steel face with operating key, bronze interior parts, 20 mm ( $\frac{3}{4}$ ") dia. solder inlet, 20 mm ( $\frac{3}{4}$ ") dia. hose connection, and integral vacuum breaker.
  - .2 Acceptable products are:
    - .1 Watts Industries (Canada) Inc. #HY-430;
    - .2 Jay R. Smith #5619-SAP-98;
    - .3 Zurn #Z1333 "ECOLOTROL";
    - .4 Mifab #MHY-30.
  - .3 Surface – Exposed – Cold Water – Unfinished Areas
    - .1 Brass or bronze hose bibb with hose end vacuum breaker.
    - .2 Acceptable products are:
      - .1 Watts Industries (Canada) Inc. #SC8-1;
      - .2 Jay R. Smith #5609QT-SAP;
      - .3 Zurn/Wilkins # Z1341 with hose end vacuum breaker;
      - .4 Chicago Faucets #293-E27CP.
    - .4 Exposed – Unfinished Areas – Hot and Cold Water
      - .1 Mixing faucet for surface mounting.
      - .2 Acceptable products are:
        - .1 Watts Industries (Canada) Inc. #HY-300-2-VB;
        - .2 Jay R. Smith #5560QT-LB-SAP;
        - .3 Zurn #Z841L1-RC;
        - .4 Delta Commercial #28T8083.

## 2.11 EXTERIOR NON-FREEZE WALL HYDRANTS

- .1 Flush-Concealed
  - .1 Recessed, encased, self-draining hydrants, each complete with a copper casing, operating rod assembly to suit wall thickness, polished nickel bronze box with hinged locking cover, 20 mm ( $\frac{3}{4}$ ") dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.
  - .2 Acceptable products are:

- .1 Watts Industries (Canada) Inc. #HY-725;
  - .2 Jay R. Smith #5519-98;
  - .3 Zurn #Z1320;
  - .4 Mifab #MHY-26.
- .2 Semi-Recessed
    - .1 Self-draining hydrants, each complete with a copper casing, operating rod assembly to suit the wall thickness, 20 mm ( $\frac{3}{4}$ " dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.
    - .2 Acceptable products are:
      - .1 Watts Industries (Canada) Inc. #HY-420;
      - .2 Jay R. Smith #5619-98;
      - .3 Zurn #Z1321;
      - .4 Mifab #MHY-16.

## 2.12 FLOOR DRAIN TRAP SEAL PRIMERS

- .1 Primer Valve Type
  - .1 Precision Plumbing Products Inc. Model P2-500 trap primer valve, constructed of brass, adjustable to high or low water pressures and complete with "O" ring seals, 12 mm ( $\frac{1}{2}$ " threaded inlet and outlet connections, and, for priming two traps from the same primer, a DU-2 dual outlet distribution unit.
- .2 Primer Valve Type with Manifold
  - .1 Precision Plumbing Products Inc. Model P1-500 trap primer valve constructed as specified above for the Model P2-500 primer valve, complete with a Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.
- .3 Electronic Type
  - .1 Precision Plumbing Products #PT Series surface wall mounting, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
    - .1 galvanized steel cabinet with door;
    - .2 20 mm ( $\frac{3}{4}$ " dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
    - .3 solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm ( $\frac{1}{2}$ " dia. compression type copper tube connections on 40 mm ( $1\frac{1}{2}$ " centres with quantity to suit the number of items to be primed;



- .4 control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

## 2.13 WATER HAMMER ARRESTORS

- .1 Piston type, sealed, all stainless steel construction, pressurized water hammer arrestors suitable for either vertical or horizontal installation, each complete with a pressurized compression chamber, welded nesting-type expansion bellows surrounded by non-toxic mineral oil, and a male threaded nipple connection.
- .2 Acceptable products are:
  - .1 Jay R. Smith 5000 Series;
  - .2 Precision Plumbing Products "SS" Series.
- .3 Piston type, sealed, pressurized water hammer arrestors suitable for either horizontal or vertical installation, each complete with a hard drawn copper body, "O"-ring piston seals, an air charge, and an inlet opening equal to diameter of pipe in which arrestor is required.
- .4 Acceptable products are:
  - .1 Watts Industries (Canada) Inc.;
  - .2 Zurn #Z1705;
  - .3 Precision Plumbing Products Inc. #SC;
  - .4 Mifab MWH Series.

## 2.14 BACKFLOW PREVENTERS

- .1 Double Check Valve Assembly
  - .1 Minimum 1205 kPa (175 psi) rated lead-free dual check valve assembly backflow preventer to CAN/CSA B64 (including supplements), complete with tight-closing resilient seated shut-off valves, test cocks and strainer.
  - .2 Acceptable manufacturers are:
    - .1 Watts Industries Canada;
    - .2 Zurn/Wilkins;
    - .3 Apollo Valves (Conbraco Industries).
- .2 Reduced Pressure Zone Assembly
  - .1 Lead-free reduced pressure zone assembly backflow preventer in accordance with CAN/CSA B64 (including supplements), each of bronze or epoxy coated cast iron bronze fitted construction depending on size, and complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting.
  - .2 Acceptable products are:

- .1 Watts Industries #LF009QT-S for 12 mm (½") size, #LF909QT-S for 20 mm to 50 mm (¾" to 2") size, and #LF909-NRS-S for 65 mm (2-½") and larger size;
- .2 Zurn/Wilkins 975XL2 and 375 Series;
- .3 "Apollo" Valves manufactured by Conbraco Industries Inc. Series 4ALF;
- .4 Danfoss Flomatic Corp. Series RPZ.

## **2.15 PIPING EXPANSION COMPENSATORS AND GUIDES**

- .1 Pressurized type, selected to withstand system pressure and to suit calculated movement from -5°C (23°F) to maximum operating temperature plus 25% safety factor, complete with stainless steel bellows and shroud, copper tube sweat type female ends, anti-torque device, and proper and suitable alignment guides for both sides of each compensator.
- .2 Acceptable products are:
  - .1 Senior Flexonics Series HB;
  - .2 Hyspan Precision Products Series 8500.

## **2.16 PIPE ANCHORS**

- .1 Welded structural black steel anchors of a design, size, and type to securely anchor pipe at point shown. Each anchor is to withstand 150% axial thrust, and is to be designed and detailed by a professional structural engineer registered and licensed in jurisdiction of the work. Submit anchor design and fabrication shop drawings, stamped by design engineer.

## **2.17 AIR VENTS**

- .1 Equal to ITT Hoffman Specialty No. 78 cast brass, 1035 kPa (150 psi) rated, 20 mm (¾") straight water main vent valves, each tapped at the top for a 3.2 mm (1/8") safety drain connection.

## **2.18 DOMESTIC WATER THERMAL EXPANSION TANK**

- .1 Pre-charged domestic water thermal expansion tank in accordance with Section VIII of the ASME Boiler and Pressure Code, carbon steel outer shell construction and complete with fixed butyl rubber bladder to prevent water from contacting shell interior, top NPT stainless steel system connection, 7.6 mm to 813 mm (0.301" to 32") charging valve connection and prime painted exterior.
- .2 Acceptable products are:
  - .1 Watts Industries (Canada) Inc. Series DETA;
  - .2 Zurn/Wilkins Model WTTA.
  - .3 Amtrol

### **3 EXECUTION**

#### **3.01 PIPING INSTALLATION REQUIREMENTS**

- .1 Provide required domestic water piping.
- .2 Piping, unless otherwise specified, is as follows:
  - .1 for underground piping 100 mm (4") dia. and larger outside and/or inside the building – rigid PVC;
  - .2 for pipe 100 mm (4") dia. and larger inside building and above ground – Schedule 10 stainless steel;
  - .3 for 12 mm (½") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;
  - .4 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints or Type "L" hard copper with pressure coupled mechanical joints.
- .3 Lay pipes true to line and grade with bells up grade. Fit sections together so that, when complete, pipe has a smooth and uniform invert. Keep pipe thoroughly clean so jointed compound will adhere. Inspect pipe for defects before being lowered into trench.
- .4 Slope piping so it can be completely drained.
- .5 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

#### **3.02 INSTALLATION OF SHUT-OFF AND CHECK VALVES**

- .1 Refer to Part 3 of Section entitled Basic Mechanical Materials and Methods.
- .2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

#### **3.03 INSTALLATION OF DRAIN VALVES**

- .1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.
- .2 Locate drain valves so they are easily accessible.

#### **3.04 INSTALLATION OF DOMESTIC HOT WATER PIPING BALANCING VALVES**

- .1 Provide balancing valves in domestic hot water recirculation piping where shown or required.
- .2 Locate each valve so it is easily accessible.

**3.05 INSTALLATION OF PARTITION STOPS**

- .1 Provide partition stops in domestic water piping to each group of suite washroom plumbing fixtures. Locate partition stops in piping near floor level in inconspicuous but accessible locations. Confirm exact locations prior to roughing-in.

**3.06 INSTALLATION OF DOMESTIC HOT WATER THERMOSTATIC MIXING VALVES**

- .1 Provide a domestic hot water thermostatic mixing valve assembly and wall mount.
- .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .3 Identify each valve and its water temperature delivery setting with an engraved nameplate.

**3.07 INSTALLATION OF WATER METER**

- .1 Provide domestic water service meter. Secure meter in place on a concrete housekeeping pad and connect with piping, including required valve by-pass.
- .2 Installation of water meter must comply with local municipal requirement.

**3.08 INSTALLATION OF HOSE BIBBS**

- .1 Provide hose bibbs.
- .2 Unless otherwise shown, specified, or required, mount hose bibbs approximately 1 m (3') above floor. Confirm exact locations prior to roughing-in.

**3.09 INSTALLATION OF EXTERIOR NON-FREEZE WALL HYDRANTS**

- .1 Provide non-freeze wall hydrants.
- .2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2') above grade level. Confirm exact locations prior to roughing-in.
- .3 Provide a shut-off valve inside building to each exterior non-freeze wall hydrant.

**3.10 INSTALLATION OF TRAP SEAL PRIMERS**

- .1 Provide required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on drawings or not.
- .2 Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from same primer valve, provide appropriate supply and distribution tube assemblies. Ensure primer valves are accessible.
- .3 Provide 115 volt, electronic, surface wall mounting trap primer assemblies for multiple (4 to 30) traps. Include for a 115 volt 15 ampere panel breaker and wiring in conduit from closest panelboards to primer assembly, all to wiring standards of Electrical Division. Adjust primer water flow and timing to suit number of traps served.

- .4 Ensure trap primer piping is secured to floor drain primer tapings and not terminated through the tapping in the throat of the drain.

### **3.11 INSTALLATION OF SHOCK ABSORBERS**

- .1 Provide accessible shock absorbers in domestic water piping.
- .2 Ensure size of each shock absorber is properly selected to suit size of domestic water pipe and equipment pipe is connected to.

### **3.12 INSTALLATION OF WATER HAMMER ARRESTORS**

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
  - .1 in headers at groups of plumbing fixtures;
  - .2 at top of risers;
  - .3 at ends of long horizontal runs of piping;
  - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
  - .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with manufacturer's instructions and details.

### **3.13 INSTALLATION OF BACKFLOW PREVENTERS**

- .1 Provide a double check valve assembly backflow preventer on incoming DCW service. Provide a reduced pressure zone assembly backflow preventer in each direct domestic water connection to equipment other than plumbing fixtures and fittings.
- .2 Locate each backflow preventer on floor or wall between 765 mm and maximum 1.5 m (30" and 60") above floor such that it is easily accessible for maintenance and testing. Equip each backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.
- .3 Test operation of each backflow preventer in accordance with requirements of CAN/CSA B64 by personnel certified for such testing by governing authorities, and submit signed test results and a properly and clearly identified and marked inspection and test record card for each backflow preventer.

### **3.14 INSTALLATION OF EXPANSION COMPENSATORS, GUIDES AND ANCHORS**

- .1 Provide expansion compensators in domestic water piping.
- .2 Ensure pipe ends are properly aligned. Provide alignment guides on each side of expansion compensators, properly secured to building structure.
- .3 Provide anchors to secure domestic water piping to structure. Locate anchors generally where shown but with exact locations to suit piping as installed and requirements of reviewed anchor shop drawings.

- .4 When installation of anchors is complete, arrange, and pay for anchor design engineer to visit site to review anchor installation. Submit a letter from design engineer confirming each anchor is properly installed.
- .5 For PEX installations:
  - .1 Utilize continuous support tray as resembled by piping manufacturer to mitigate thermal expansion and contraction. Natural corners and offsets may also be used. In conjunction with above options, provide anchor points every 20 m (65') for hydronic systems on continuous runs without jogs. Refer to manufacturer's installation instructions.
  - .2 Piping Hanger Spacing: Install hangers for PEX piping with following maximum spacing:
    - .1 NPS  $\frac{3}{4}$  (DN 20) and smaller: 815 mm (32") with 10 mm (3/8") rod;
    - .2 NPS 1 to NPS 3 (DN 25 to DN 75): 1200mm (48") with 10 mm (3/8") rod;
    - .3 NPS 4 (DN 110) and smaller: continuously supported by PEX pipe support or metallic V-channels that:
      - .1 are supported every 1.8 m (6') for NPS  $\frac{3}{4}$  (DN 20) and smaller;
      - .2 are supported every 2.4 m (8') for NPS 1 to 4 (DN 25 to DN 110).
    - .4 Have a maximum cantilever, measured from support to end of CTS support channel, of 0.5 m (1.5').
  - .3 Riser Supports: Install CTS riser clamps at base of each floor and at top of every other floor. Install mid-story guides between each floor.

### **3.15 INSTALLATION OF AIR VENTS**

- .1 Provide accessible air vents in domestic water piping to prevent air binding.
- .2 Extend copper indirect drain piping from top drain connection of each vent to nearest suitable drain.
- .3 Locate exact vent locations on as-built record drawings.

### **3.16 INSTALLATION OF DOMESTIC WATER THERMAL EXPANSION TANK**

- .1 Provide domestic water thermal expansion tanks.
- .2 Unless otherwise specified, mount at least 450 mm (18") from cold water inlet to domestic water heater.
- .3 Adjust pre-charge to match incoming water pressure after installation.
- .4 Install in accordance with manufacturer's instructions and as per local governing Codes and Regulations.

### 3.17 FLUSHING AND DISINFECTING PIPING

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .3 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.
- .4 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.
- .2 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.

## **2 PRODUCTS**

### **2.01 PIPE, FITTINGS AND JOINTS**

- .1 PVC Sewer
  - .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
  - .2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.
- .2 PVC - DWV
  - .1 Equal to Ipex System XFR 15-50 rigid PVC drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating less than 25 and a smoke developed rating less than 50 when tested to CAN/ULC S102.2, solvent weld joints, and, for fire barrier penetration, approved firestop conforming to CAN/ULC S115.
- .3 Copper - Solder Joint
  - .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
- .4 Cast Iron
  - .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .5 Copper - Victaulic Coupling Joint
  - .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.
- .6 Galvanized Steel - Victaulic Coupling Joint
  - .1 Schedule 40 mild steel, galvanized, ASTM A53, factory or site rolled grooved, complete with Victaulic galvanized ductile iron grooved end fittings and, unless otherwise specified, Victaulic Style 77 hot dip galvanized mechanical joint couplings with Grade M gaskets.

### **2.02 SHUT-OFF AND CHECK VALVES**

- .1 Shut-off Valves



- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass body, blowout-proof stem, chrome plated solid brass ball, solder or screwed ends as required, and removable lever handle.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 5049A or Fig. 5044A;
  - .2 Milwaukee Valve Co. #BA-155 or #BA -125;
  - .3 Kitz Corporation Code 58 or Code 59;
  - .4 Victaulic Co. of Canada Ltd. Series 722;
  - .5 Apollo Valves # 77-100 or # 77-200;
  - .6 Watts Industries (Canada) Inc. #FBVS-3C.

.2 Check Valves

- .1 Class 125, bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with solder or screwed ends as required, and, for horizontal piping, Class 125, bronze 1380 kPa (200 psi) WOG rated swing check valves with solder or screwed ends.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 231 or Fig. 236 or Fig. 237;
  - .2 Milwaukee Valve Co. #1510 or #510;
  - .3 Kitz Corporation Code 36 or Code 22 or Code 23.

**2.03 VENT STACK COVERS**

- .1 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.
- .2 Each vent stack cover is to be complete with a vandal-proof cap.

**2.04 CLEANOUTS**

- .1 Horizontal Piping
  - .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 Vertical Piping
  - .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.

**2.05 FLOOR CLEANOUT TERMINATIONS**

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.
- .2 Acceptable products are:
  - .1 Watts Industries (Canada) Ltd. # CO-200-R-1;
  - .2 Jay R. Smith #4020-F-C Series;
  - .3 Zurn # ZN-1602-SP Series;
  - .4 Mifab # C1100-XR-1 or #C1000-R-3.
- .3 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

## **2.06 FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS**

- .1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex based paint coating.
- .2 Floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.
- .3 Acceptable manufacturers are:
  - .1 Watts Industries (Canada) Ltd.;
  - .2 Jay R. Smith Manufacturing Co.;
  - .3 Zurn Industries Ltd.;
  - .4 Mifab Inc.

## **2.07 ROOF DRAINS**

- .1 Unless otherwise specified or indicated, roof drains are to be cast iron body drains with aluminium domes, in accordance with the drawing symbol list. Cast iron components are to be factory finished with latex based paint coating.
- .2 Acceptable manufacturers are:
  - .1 Watts Industries (Canada) Ltd.;
  - .2 Jay R. Smith Manufacturing Co.;
  - .3 Zurn Industries Ltd.;
  - .4 Mifab Inc.

## **3 EXECUTION**

### 3.01 UNDERGROUND MUNICIPAL SERVICE CONNECTION

- .1 Make required arrangements with Municipality for installation of drain service piping mains from Municipal main to property line.
- .2 Pay charges levied by Municipality for service connection work.
- .3 Municipal charges for underground street service connection work will be paid out of a prime cost allowance. Submit original copies of invoices issued by Municipality for street service connection work.

### 3.02 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

- .1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:
  - .1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;
  - .2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;
  - .3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
  - .4 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV;
  - .5 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.
- .2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').
- .3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
- .4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').
- .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
- .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

### 3.03 INSTALLATION OF SHUT-OFF AND CHECK VALVES

- .1 Provide a shut-off valve and a check valve in discharge piping of each drainage pump.
- .2 Locate valves so they are easily accessible without the use of ladders or other such devices.

### **3.04 SUPPLY OF VENT STACK COVERS**

- .1 Supply a properly sized vent stack cover for each vent stack penetrating roof.
- .2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

### **3.05 INSTALLATION OF CLEANOUTS**

- .1 Provide cleanouts in drainage piping in locations as follows:
  - .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
  - .2 at or as close as practicable to the foot of each drainage stack;
  - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
  - .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
  - .5 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

### **3.06 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS**

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.
- .2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.
- .4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

### **3.07 INSTALLATION OF FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS**

- .1 Provide floor drains, funnel floor drains and hub drains.
- .2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.

- .3 Equip each drain with a trap.
- .4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
- .5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.
- .6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

### **3.08 INSTALLATION OF ROOF DRAINS**

- .1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of roofing work. Connect with piping and provide accessories.
- .2 Protect roof drains from damage and entrance of debris until roofing work is complete, and refinish any areas where cast iron factory finish has been damaged or removed, including rusted areas.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all equipment and associated hardware specified in this Section.
- .2 Include pump motor product data sheets and pump performance curves with shop drawing/product data sheet submission.
- .3 Submit manufacturer/supplier installation certification letters as specified in Part 3 of this Section.
- .4 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this Section.

## **2 PRODUCTS**

### **2.01 HORIZONTAL IN-LINE CIRCULATING PUMPS**

- .1 Bronze construction centrifugal pumps in accordance with drawing schedule and complete with:
  - .1 lead free cast bronze casing with flanged pipe connections;
  - .2 alloy steel shaft with integral thrust collar, copper shaft sleeve, and oil lubricated bronze sleeve bearings;
  - .3 balanced lead free cast bronze impeller;
  - .4 motor conforming to requirements of Section entitled Basic Mechanical Materials and Methods, connected to motor by means of a 4-spring coupling with guard;
  - .5 mechanical seal.
- .2 Acceptable manufactures are:
  - .1 S.A. Armstrong Ltd.;
  - .2 ITT Bell & Gossett;
  - .3 Grundfos Canada Inc.;
  - .4 Patterson Pump Company.

### **2.02 CIRCULATING PUMP AUTOMATIC CONTROL**

- .1 Equal to ITT Bell & Gossett Model TC-1 115 volt, programmable, Automatic Timer Kit to control circulating pump on and off at pre-set minimum 15 minute intervals, and equipped with ON (continuous run), OFF (at all times), and TIMER (run at programmed times) modes.
- .2 Equal to ITT Bell & Gossett AQS Series 115 volt Aquastat to automatically control pump on and off in response to domestic water temperature and equipped with a stainless steel pipe clip, bimetal sensing element, and insulated #18 AWG 450 mm (18") wire leads.

### 2.03 CONDENSATE DRAINAGE PUMP SET

- .1 Equal to Shipco Pumps type LPCD package type, duplex condensate drainage pump set in accordance with drawing schedule, complete with:
  - .1 vented heavy-gauge steel receiver;
  - .2 2 vertical receiver mounted pumps, each equipped with a bronze impeller, bronze wear ring, and a TEFC motor in accordance with Section entitled Basic Mechanical Materials and Methods;
  - .3 factory mounted and pre-wired type "DC1" power and control panel with NEMA 1 (NEMA 2 if sprinklered area) enamelled steel enclosure, and following:
    - .1 door interlocked main disconnect switch, a circuit breaker, overload relay, across-the-line contactor;
    - .2 H-O-A for each pump;
    - .3 power "ON" and 2 pump "RUN" pilot lights;
    - .4 control transformer, circuitry and relays for automatic transfer to lag pump in the case of motor overload or short circuit;
    - .5 high level alarm buzzer with silence/test switch, red pilot light, and alarm relay.
  - .4 pre-wired float switch.

### 2.04 SEALED COMBUSTION HOT WATER HEATER

- .1 A.O. Smith #BTH Cyclone Series minimum 95% thermal efficiency, with model number and performance as specified on drawings, meeting requirements of latest edition ASHRAE 90.1, and in accordance with following requirements:
  - .1 1103 kPa (160 psi) maximum hydrostatic working pressure;
  - .2 natural gas modulating burner to adjust input based on demand;
  - .3 down-fired power burner designed for precise mixing of air and gas for optimum efficiency, requiring no special calibration on start-up;
  - .4 maintenance-free, non-sacrificial power anodes;
  - .5 seamless glass-lined tank construction, with glass lining applied to all water-side surfaces;
  - .6 factory insulation;
  - .7 CSA certified and ASME rated temperature and pressure relief valve;
  - .8 integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display, and digital temperature readout;
  - .9 complies with local requirements for low NOx emissions;

- .10 design certified by UL in accordance with ANSI Z21.10.3/CSA 4.3 standards.
- .2 Acceptable manufacturers are:
  - .1 A.O. Smith Water Products Co.;
  - .2 John Wood (GSW Water Heating Co.);
  - .3 Rheem-Ruud Canada Ltd.;
  - .4 Bradford White Canada Inc.

### **2.05 CONDENSATE NEUTRALIZING KIT**

- .1 Refillable, low-profile condensate neutralizing kit, suitable for no less than 12 months continuous operation at full condensing rate, and suitable in all respects for associated condensing heater.

## **3 EXECUTION**

### **3.01 DRAINAGE COORDINATION**

- .1 Coordinate drain requirements of plumbing equipment provided by Mechanical Division and/or Owner with location of drains specified in Section 22 13 00.

### **3.02 INSTALLATION OF CIRCULATING PUMPS**

- .1 Provide horizontal in-line domestic hot water circulating pumps.
- .2 Install pumps in place in vertical piping approximately 1.2 m (4') above floor in accordance with pump manufacturer's instructions.
- .3 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .4 Include for 2 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

### **3.03 INSTALLATION OF CIRCULATING PUMP CONTROL**

- .1 Provide a programmable timer to control circulating pump on and off at pre-set times. Mount timer and connect to pump in accordance with timer manufacturer's instructions. Programme timer in accordance with Consultant's instructions.
- .2 Provide an aquastat to control pump on and off in response to domestic water temperature. Install in accordance with manufacturer's instructions. Set on and off temperatures in accordance with Consultant's instructions.

### **3.04 INSTALLATION OF CONDENSATE DRAINAGE PUMP SET**

- .1 Provide a package type duplex condensate drainage pump set to pump equipment condensate drainage into a gravity discharge main. Install in accordance with manufacturer's instructions and drawing installation requirements.



- .2 Hand power and control panel to electrical trade at site for installation. Confirm exact location prior to installation.
- .3 When installation is complete, arrange for pump set supplier to visit site to examine installation and certify it correct in writing. Submit a copy of the certification letter.

**3.05 INSTALLATION OF SEALED COMBUSTION HOT WATER HEATERS**

- .1 Provide gas fired domestic hot water heaters.
- .2 Install in accordance with manufacturer's instructions. Secure each heater in place, level, and plumb, on a concrete housekeeping pad.
- .3 Pipe temperature/pressure relief valve outlet to drain. Pipe condensate drain connection to drain.
- .4 Coordinate installation with electrical trade who will connect heater with power wiring.
- .5 Unless otherwise specified or instructed, set thermostat to produce 48.8°C (120°F) hot water.
- .6 Provide combustion air and flue gas vent piping for each heater in accordance with requirements of Section entitled Flue Gas Vents.
- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .8 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements. Submit a copy of the letter prior to Substantial Performance of the Work.
- .9 Include for 2 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

**3.06 INSTALLATION OF CONDENSATE NEUTRALIZING KIT**

- .1 Provide condensate neutralizing kit.
- .2 Install in accordance with manufacturer's instructions.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings.

**2 PRODUCTS**

**2.01 GENERAL RE: PLUMBING FIXTURES AND FITTINGS**

- .1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.
- .2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.
- .3 Unless otherwise specified, vitreous china, porcelain enamelled, and acrylic finished fixtures are to be white.
- .4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.
- .5 Fittings located in areas other than private washrooms are to be vandal-proof.
- .6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.
- .7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.
- .8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.
- .9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum #17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.
- .10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.
- .11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.
- .12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

**2.02 PLUMBING FIXTURES AND FITTINGS**

- .1 Plumbing fixtures and fittings are to be in accordance with schedule on drawing

## 2.03 ACCEPTABLE MANUFACTURERS

- .1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:
  - .1 Plumbing Brass:
    - .1 American Standard;
    - .2 Delta Commercial;
    - .3 Chicago Faucet;
    - .4 Moen Commercial.
  - .2 Stainless Steel Sinks:
    - .1 Franke Commercial;
    - .2 Novanni Commercial;
    - .3 Aristaline;
    - .4 Arch Metal Ind.
  - .3 Mop Sinks:
    - .1 Stern Williams;
    - .2 Acorn Engineering;
    - .3 Zurn Industries.
  - .4 Drain Fittings, Angle Supplies, and Traps:
    - .1 McGuire;
    - .2 American Standard;
    - .3 Delta Commercial;
    - .4 Zurn Industries.
  - .5 Fixture Carriers:
    - .1 Watts Industries;
    - .2 Jay R. Smith;
    - .3 Zurn Industries.
  - .6 Hose Bibbs:
    - .1 Jay R. Smith;

- .2 Zurn Industries.
- .7 Water Closets, Lavatories, and Urinal:
  - .1 American Standard;
  - .2 Zurn Industries;
  - .3 Kohler.
- .8 Thermostatic Mixing Valves:
  - .1 Lawler;
  - .2 Delta Commercial;
  - .3 Leonard.
- .9 Shower and Associated Trim:
  - .1 American Standard;
  - .2 Delta Commercial;
  - .3 Zurn Industries;
  - .4 Moen Commercial.
- .10 Toilet Seats:
  - .1 Olsonite;
  - .2 Centoco;
  - .3 Bemis Commercial.

## **2.04 CAULKING**

- .1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by Consultant from sealant manufacturer's standard colour range.

## **3 EXECUTION**

### **3.01 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS**

- .1 Provide required plumbing fixtures and fittings.
- .2 Where new fixtures and fittings are to be connected to existing piping, include for required piping revisions.

- .3 Connect plumbing fixtures and fittings with piping sized in accordance with drawing schedule. Refer to manufacturer's published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

FIXTURE AND/OR FITTING	DRAIN SIZE MM (IN.)	VENT SIZE MM (IN.)	DHW SIZE MM (IN.)	DCW SIZE MM (IN.)	TEMP WATER SIZE MM (IN.)
Water Closets (Tank)	100 (4)	38 (1-½)	-----	12 (½)	-----
Lavatories	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	-----
Counter Sinks	38 (1-½)	32 (1-¼)	12 (½)	12 (½)	-----
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	-----
Laundry Washer	50 (2)	38 (1-½)	20 (¾)	20 (¾)	

- .4 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.
- .5 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.
- .6 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).
- .7 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.
- .8 Set mop service basins on floor over drain piping and connect to roughed-in service. Install wall supply trim and any accessories specified.

### 3.02 CAULKING AT PLUMBING FIXTURES AND FITTINGS

- .1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.
- .2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.
- .3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.
- .4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

### 3.03 CLOTHES WASHER CONNECTIONS

- .1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:

- .1 15 mm (1/2") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;
- .2 40 mm (1-1/2") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data for all products specified in Part 2 of this Section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.
- .2 For each gas pressure regulating station, submit:
  - .1 selection sheet for each PRV, indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size;
  - .2 selection sheet for each relief valve(s) serving a PRV.

### **1.02 QUALITY ASSURANCE**

- .1 Gas system work is to be in accordance with requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
- .2 Gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under TSSA Act.
- .3 Apply for, on TSSA forms, approval of gas system design by TSSA prior to work beginning at site and prior to ordering any equipment. Submit completed TSSA Form and copies of shop drawings/product data sheets as required to TSSA and obtain an approval certificate. Pay costs for TSSA review and approval process. If TSSA requires revisions to the system and revisions result in an extra cost, a Notice of Change will be issued by Consultant for the revision.

## **2 PRODUCTS**

### **2.01 PIPE, FITTINGS AND JOINTS**

- .1 Uncoated Black Steel - Screwed Joints
  - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.
- .2 Uncoated Black Steel - Welded Joints
  - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.
- .3 Copper - Uncoated
  - .1 Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45° flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.
- .4 Flexible Stainless Steel

- .1 Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. Supply tubing in coils and complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.
- .2 Acceptable products are:
  - .1 Tru-Flex Metal Hose LLC. "Pro-Flex";
  - .2 Titeflex Corp. "Gastite";
  - .3 Omega Flex Canada "TracPipe".

## 2.02 PIPING UNIONS

- .1 Screwed Piping
  - .1 Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Flanged Piping
  - .1 Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.
- .3 Copper to Steel
  - .1 Equal to Kamco Products "Copper Stopper".

## 2.03 SHUT-OFF VALVES

- .1 Ball Type
  - .1 CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends.
  - .2 Acceptable products are:
    - .1 Neo Valves Inc. #425;
    - .2 Kitz Corp. Code 58;
    - .3 Toyo Valve Co. Fig. 5044A.
- .2 Plug or Ball Type
  - .1 CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle, or full port carbon steel ball valves with flanged ends.
  - .2 Acceptable products are:



- .1 Neo Valves Inc. #1AS40114 plug valve;
- .2 Newman Hattersley #171M plug valve;
- .3 Kitz Corp. Code No. 150 SCTAM-FS-CGA ball valve.

## **2.04 PRESSURE REGULATORS**

- .1 CSA certified pressure regulators as follows:
  - .1 non-vented type: lever action, dead end lockup type, each complete with a vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm;
  - .2 vented type: spring-loaded self-operated design, tight closing, selected for facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:
    - .1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel;
    - .2 aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring;
    - .3 throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of regulator in coordination with regulator capacity.
- .2 Acceptable manufacturers are:
  - .1 Maxitrol Co.;
  - .2 Fisher Controls;
  - .3 Leslie Controls Inc.;
  - .4 Lakeside Process Controls.

## **3 EXECUTION**

### **3.01 DEMOLITION**

- .1 Perform required gas system demolition work. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

### **3.02 NATURAL GAS SERVICE**

- .1 Make required arrangement with natural gas supply utility on behalf of Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.
- .2 Provide 2 m (7') high minimum 200 mm (8") diameter Schedule 80 galvanized steel concrete filled bollards at meter-regulator location in a pattern to protect meter-regulator. Install pipe straight and plumb a 1.2 m (4') below grade in a continuous 600 mm (2') diameter reinforced concrete footing. Smoothly crown top of concrete above the top of the pipe.

### 3.03 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

- .1 Provide required natural gas distribution piping and connect gas fired or operated equipment, and provide required vent piping to atmosphere, including vent piping from pressure regulators. Perform piping work in accordance with requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
- .2 Piping is to be as follows:
  - .1 for underground piping, coated Schedule 40 black steel, coated soft copper, or polyethylene;
  - .2 for aboveground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.
- .3 Install flexible stainless steel pipe in strict accordance with pipe manufacturer's instructions.
- .4 Slope gas piping in direction of flow to low points.
- .5 Ensure supports for roof mounted piping are sized (height) to accommodate roof slope and required piping slope, and to permit installation of low point dirt pockets.
- .6 Provide full pipe diameter 150 mm (6") long drip pockets at bottom of vertical risers, at piping low points, and wherever else shown and/or required.
- .7 Identify natural gas piping aboveground with 2 coats of safety yellow enamel applied over primer, and SMS Ltd. or equal coil type vinyl identification makers with arrows.
- .8 For underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above pipe approximately 250 mm (10") below grade.
- .9 Rough-in required natural gas piping for kitchen and laundry equipment in accordance with drawing plans and schedules. Obtain accurately dimensioned rough-in drawings for equipment and confirm exact locations prior to roughing-in. When equipment has been installed, connect equipment from the roughed-in Work. Provide shut-off valves in piping connections to equipment.
- .10 Include for mounting of a solenoid valve in the gas piping to kitchen cooking equipment.

### 3.04 INSTALLATION OF SHUT-OFF VALVES

- .1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.
- .2 Ensure valves are located for easy accessibility and maintenance.

### 3.05 INSTALLATION OF PRESSURE REGULATORS

- .1 Provide pressure regulators in gas distribution piping where indicated and/or required.
- .2 For indoor appliances, use lever acting design vent limiter type, sized as shown and mounted in a horizontal upright position in strict accordance with manufacturer's instructions. Note: these pressure regulators do not require vent piping.

- .3 Use vented type pressure regulators for all other applications.
- .4 Install regulating stations in accordance with requirements of CAN/CSA B149.1.
- .5 Provide 6 mm (¼") diameter test ports upstream and downstream of each regulator assembly.
- .6 Locate outdoor regulating stations a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.
- .7 Locate indoor regulating stations in locations accessible without use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.
- .8 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all products specified in this Section except piping and unions.
- .2 Submit motor product data sheets and certified performance curves with all pump shop drawings.
- .3 Submit with delivery of each unit a copy of factory inspection and test report, and include a copy of each report with O & M Manual project close-out data.
- .4 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .5 Prior to Substantial Performance of the Work, submit a spare seal flush line filter for each pump equipped with a seal flush line.
- .6 Shop drawings for piping anchors must be prepared and stamped by a professional Structural Engineer registered in the jurisdiction of the work. Refer to requirements for Contractor retained engineers specified in Section entitled Mechanical Work General Instructions.
- .7 Submit a letter from pipe anchor design engineer to stating engineer has visited site to examine installation of pipe anchors and pipe anchor installation is in accordance with reviewed anchor shop drawing.

**1.02 QUALITY ASSURANCE**

- .1 Pump motors are to comply with requirements of Section entitled Basic Mechanical Materials and Methods.

**2 PRODUCTS**

**2.01 PIPE, FITTINGS AND JOINTS**

- .1 Black Steel - Screwed Joint
  - .1 Mild black carbon steel, Grade B, ASTM A53, complete with Class 125 cast iron threaded fittings to ANSI/ASME B16.4, and screwed joints.
- .2 Black Steel - Welded Joint
  - .1 Mild black carbon steel, Grade B, ASTM A53, mill or site bevelled, complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, with long sweep pattern elbows unless otherwise specified, and welded joints.
- .3 Black Steel - Grooved End Mechanical Joint
  - .1 Mild black carbon steel, Grade B, ASTM A53, factory or site roll grooved, complete with cast ductile iron grooved end fittings, including full flow elbows, and conforming to ASTM A536.
  - .2 Acceptable products are:

- .1 Victaulic Style 107 "QuickVic" rigid couplings for sizes 50 mm (2") to 200 mm (8"), Style 07 "Zero-Flex" rigid couplings for sizes 250 mm (10") to 300 mm (12"), Style W07 AGS rigid couplings for sizes 350 mm (14") to 1525 mm (60");
  - .2 Gruvlok Fig. 7402 "SlideLOK" for sizes 50 mm (2") to 200 mm (8"), Fig. 7401 "Rigidlok" for sizes 250 mm (10") to 610 mm (24").
- .4 Soft Copper Pipe
    - .1 Type "L" seamless soft copper to ASTM B77.
  - .5 Hard Copper - Solder Joint
    - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with wrought copper fittings to ANSI B16.22, and 95% tin / 5% Antimony solder joints.
  - .6 Hard Copper - Pressure Coupled Joint
    - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with Viega "ProPress with Smart Connect feature" system copper fittings with EDPM seals, and pressure type crimped joints made by use of manufacturer recommended tool.

## 2.02 PIPING UNIONS

- .1 Screwed Piping
  - .1 Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Flanged Piping
  - .1 Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.

## 2.03 SHUT-OFF VALVES

- .1 Ball Type
  - .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass or bronze body and cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, threaded ends, and removable lever handle.
  - .2 Acceptable products are:
    - .1 Toyo Valve Co. Fig. 5044A;
    - .2 Watts Industries (Canada) Inc. #FBV-3;
    - .3 Kitz Corp. Code 58;
    - .4 Victaulic Co. of Canada Ltd. Series 722;
    - .5 Apollo Valve #77-100.

.2 Butterfly Type

- .1 Cast ductile iron, lug body style, 1200 kPa (175 psi) rated butterfly valve, each complete with a neck to permit 50 mm (2") of insulation above the flange, a field replaceable EPDM seat, ductile iron disc, stainless steel shaft with EPDM seal, a lever handle for valves to and including 150 mm (6") diameter, a handwheel and gear type operator for valves larger than 150 mm (6") diameter, and each suitable for bubble-tight dead end service with valve closed and either side of connecting piping removed.
- .2 Acceptable products are:
  - .1 DeZurik of Canada Ltd., Figure No. 632;
  - .2 Victaulic Co. of Canada Ltd. Vic-300 MasterSeal or AGS Vic-300;
  - .3 Apollo Valve 143 Series;
  - .4 Watts Industries (Canada) Inc. #BF-03;
  - .5 Kitz Corp. 6112 Series;
  - .6 Toyo Valve Co. 918DESL/G2.

**2.04 SWING CHECK VALVES**

.1 Bronze - Screwed

- .1 Class 125, 1380 kPa (200 psi) WOG rated horizontal swing check valves, each complete with a "Y" pattern bronze body, hinged brass disc, easy access screw-in cap, and screwed ends.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 236;
  - .2 Nibco #T-433;
  - .3 Kitz Corp. Code No. 22.

.2 Steel - Grooved Ends

- .1 Victaulic Co. of Canada Ltd. Series 716, 779 or W715 grooved end carbon steel check valves suitable for mounting horizontally or vertically.

.3 Cast Iron - Screwed and Flanged

- .1 Cast iron, bronze trim, 1380 kPa (200 psi) rated swing check valves, each complete with a bronze disc and seat, malleable iron hinge, bolted cover, and screwed or flanged ends as required.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 435A;

- .2 Watts Industries (Canada) Inc. #F-511;
- .3 Kitz Corp. Code No. 78.

## 2.05 VERTICAL LIFT CHECK VALVES

- .1 Class 150, 1380 kPa (200 psi) WOG rated bronze vertical lift check valves, each complete with screwed ends and a bronze disc.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 231;
  - .2 Watts Industries (Canada) Inc. #600;
  - .3 Kitz Corp. Code No. 36.

## 2.06 WAFER CHECK VALVES

- .1 Threaded lug body type, full bore, ANSI Series 150, 1965 kPa (285 psi) rated at 38°C (100°F), non-slam wafer check valves, each complete with a carbon steel body, stainless steel discs, a shaft, springs, disc stop and thrust bearings constructed of type 316 stainless steel, and seat materials to suit the application. The inside diameter of the valve must equal the inside diameter of the connecting pipe.
- .2 Acceptable products are:
  - .1 Gulf Valve Co. "WAFER CHECK";
  - .2 Watts Industries (Canada) Inc. Series ICV-125;
  - .3 The Metraflex Co. Style CVXX.

## 2.07 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) WOG rated, 20 mm ( $\frac{3}{4}$ ") diameter straight pattern bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm ( $\frac{3}{4}$ ") diameter hose, and a cap and chain.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Ltd. Fig. 5046;
  - .2 Watts Industries (Canada) Inc. #B-6000-CC;
  - .3 Kitz Corp. Code No. 68AC;
  - .4 Apollo Valves #78-104-01.

## 2.08 CIRCUIT BALANCING VALVES

- .1 Screwed or flanged as required, globe style, non-ferrous circuit balancing valves designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, and valved ports for connection to a differential pressure meter.

.2 Acceptable products are:

- .1 S.A. Armstrong Ltd. Series "CBVI" screwed or "CBVII" flanged;
- .2 Victaulic Co. of Canada Ltd. (Tour & Anderson) Series 787 screwed, Series 788 flanged, and 789 grooved end, and Series 78K "Koil Kit" valves.

## 2.09 RADIATOR SHUT-OFF AND BALANCING VALVES

.1 Heavy pattern, straight, 1750 kPa (250 psi) rated at 120°C (250°F) bronze radiator valves, each complete with composition disc, spring loaded packing, and union. Equip inlet valves with a handle for shut-off. Equip outlet valves with a lockshield for shut-off and balancing.

.2 Acceptable products are:

- .1 Dahl Brothers Canada Ltd. #11042 and #13013;
- .2 Spirax Sarco Ltd. Type R.

## 2.10 PRESSURE RELIEF VALVES

.1 ASME tested, rated, and certified, bronze or cast iron bronze fitted, 1725 kPa (250 psi) rated pressure relief valves, each capable of relieving full output of equipment it is associated with, and each factory set at 415 kPa (60 psi) unless otherwise specified.

.2 Acceptable products are:

- .1 ITT Bell & Gossett 3301/4100, or 790/1170;
- .2 Dresser Industries "CONSOLIDATED";
- .3 Spirax Sarco Ltd. SVI Series;
- .4 McDonnell & Miller Models 250 and 260;
- .5 Conbraco 10-600 Series;
- .6 Watts Industries (Canada) Inc. 174A or 740.

## 2.11 AIR VENTS

.1 Manual Air Vents

- .1 Equal to Conbraco 27 Series, 3.2 mm (1/8") diameter with a key handle.

.2 Automatic Air Vents

- .1 Float actuated air vents, each complete with a semi-steel body and cap, a stainless steel float assembly and seat, and a neoprene head.

.2 Acceptable products are:

- .1 Spirax Sarco Ltd., Type 13 W for system working pressures to 1035 kPa (150 psi), 13 WH for system working pressures greater than 1035 kPa (150 psi);



- .2 Armstrong International Inc. No. 1-AV.

## 2.12 STRAINERS

- .1 Cast iron wye shaped strainers, minimum 890 kPa (125 psi) rated and complete with a removable type 304 stainless steel screen with perforations sized to suit the application, and, for strainers 50 mm (2") diameter and larger, a blowdown pipe connection tapping.
- .2 Acceptable products are:
  - .1 Spirax Sarco Ltd. Type IF-125 screwed or Type AF-250 flanged;
  - .2 Toyo Valve Co. Ltd. Fig. 380A screwed or Fig. 381 flanged;
  - .3 Victaulic Co. of Canada Style 732 or W732 "Vic-Strainer";
  - .4 Armstrong International Inc. A1 Series;
  - .5 Watts Industries (Canada) Inc. #77SCI;
  - .6 Mueller Steam Specialty Products Model 11M screwed or Model 758 flanged.

## 2.13 PIPING EXPANSION JOINTS

- .1 Steel or Copper Branch/Runout Piping:
  - .1 Externally pressurized, 1380 kPa (200 psi) rated expansion joints with a stainless steel bellows and shroud, welding or threaded steel nipple ends for steel piping, and copper sweat nipple ends for copper piping.
  - .2 Acceptable products are:
    - .1 Senior Flexonics Ltd. Series "H";
    - .2 The Metraflex Co. Model "HP".

## 2.14 PIPING ALIGNMENT GUIDES

- .1 Prime coat painted black carbon steel pipe alignment guides sized and fabricated to suit pipe size and pipe insulation thickness.
- .2 Acceptable products are:
  - .1 Senior Flexonics Ltd. Series PGT;
  - .2 E. Myatt & Co. Ltd. Fig. 1267;
  - .3 Empire Tool & Mfg. Inc. Fig 256;
  - .4 The Metraflex Co. Style IV.

## 2.15 PIPE ANCHORS

- .1 Welded structural black steel anchors of a design, size, and type to securely anchor pipe at point shown. Each anchor is to withstand 150% of axial thrust, and, as specified in Part 1 of this Section, is to be designed and detailed by a Professional Structural Engineer.

## 2.16 AIR SEPARATOR

- .1 Vortex type vertical air separator with side tangential inlet and outlet connections, a top air outlet connection, and bottom drain connection. Separator is to be constructed of cast iron or fabricated steel for a pressure of 1105 kPa (160 psi) at 180°C (350°F) in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.
- .2 Acceptable products are:
  - .1 S.A. Armstrong Ltd. Model "VA";
  - .2 ITT Bell & Gossett "Rolairtrol";
  - .3 Taco Canada Ltd. "Vortech".

## 2.17 EXPANSION TANK

- .1 Replaceable bladder type, factory pressurized expansion tank with permanent separation of air and water, in accordance with drawing schedule and complete with:
  - .1 steel pressure tank suitable for a working pressure of 870 kPa (125 psi) at 115°C (240°F), constructed and stamped in accordance with the ASME Code for Unfired Pressure Vessels and complete with a system connection, drain connection, air charging valve, and a red oxide primer finish;
  - .2 heavy-duty butyl rubber (EDPM) bladder;
  - .3 tapping for installation of a pressure gauge;
  - .4 for horizontal tanks only, mounting saddles supplied loose;
- .2 Acceptable products are:
  - .1 Calefactio Solutions AL Series "Expanflex";
  - .2 S.A. Armstrong Ltd. Series "AX-V" Series "L";
  - .3 ITT Bell & Gossett Series "B" (ASME);
  - .4 Amtrol "Extrol";
  - .5 Taco (Canada) Ltd. "CBX" Series.

## 2.18 GENERAL RE: CIRCULATING PUMPS

- .1 Pumps are to be bronze fitted centrifugal pumps in accordance with drawing schedule, each non-overloading under all operating conditions and factory tested at specified operating conditions.

## 2.19 WET ROTOR VARIABLE SPEED HORIZONTAL IN-LINE PUMP

- .1 Grundfos Canada Inc. "Magna" Series wet rotor design, horizontal, variable frequency drive in-line pump with a head-capacity curve that has a steady rise in head from maximum to minimum flow within preferred operating range, factory tested as an assembly and with a maximum noise level when operating of 41 dBA, capable of continuous operation at 120°C (248°F), and equipped with:
  - .1 cast iron housing with flanged inlet and outlet with gauge taps, laser welded stainless steel impeller, bearing plate and shaft, stainless steel neck ring, dynamically balanced rotor with stainless steel cladding, and tungsten carbide sleeve type motor bearings;
  - .2 squirrel cage, self-venting motor suitable for a VFD, cooled by pumped fluid and complete with stator housing drain holes to permit condensed water to drain;
  - .3 bolt-on, integrated, CSA or ETL certified variable frequency drive assembly with "AUTOADAPT" function which automatically adjusts proportional pressure and sets an efficient performance curve whenever possible, an operating panel with control modules and clear indications for pump flow rate and head, and a bus communication module for site connection into building automation system.
- .2 Acceptable manufacturers are:
  - .1 Grundfos Canada Inc. "Magna" Series;
  - .2 Taco Canada Ltd. "Delta T".

### **3 EXECUTION**

#### **3.01 DEMOLITION**

- .1 Perform required hydronic piping system demolition/revision work. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

#### **3.02 PIPING INSTALLATION REQUIREMENTS**

- .1 Provide required hydronic piping. Pipe, unless otherwise specified, is to be:
  - .1 for pipe to and including 65 mm (2-1/2") diameter, Schedule 40 black steel, screwed, or type "L" hard copper with solder joints or pressure coupled joints;
  - .2 for pipe 65 mm (2-1/2") to 300 mm (12") dia. and larger, Standard weight grooved end black steel (10 mm [0.375"] thickness) pipe with grooved end fittings and couplings, or, Standard weight black steel (10 mm [0.375"] thickness) pipe with welding fittings and welded joints;
  - .3 for short branch connections to heating equipment where structural obstructions occur and site bending of pipe is advantageous, a single length of type "L" soft copper.
- .2 Slope horizontal piping mains to provide a minimum continuous up-grade of 25 mm (1") in 6 m (20') to high points. Slope branch supply and return piping connections to equipment a minimum of 25 mm (1") in 1.2 m (4'). Leave sufficient room at high points for installation and maintenance of air vents.

- .3 Install automatic control valves, piping wells and similar piping and/or equipment mounted control components required for automatic temperature control systems supplied as part of the control work. Refer to drawing control diagrams and details.
- .4 Connect equipment provided as part of the work of other Sections with piping as indicated and/or required. Refer to pipe connection details on drawings.
- .5 Provide screwed unions, removable mechanical joint couplings, or weld-on or solder-on flanges in piping at all connections to valves, strainers and similar piping system components which may need maintenance or repair, at equipment connections, in runs of piping exceeding 9 m (30') at 4.5 m (15') regular intervals to permit removal of sections of piping, and wherever else indicated on drawings.
- .6 Provide shut-off valves in piping connections to equipment, to isolate piping risers, to isolate other sections of systems as shown, and wherever else indicated on drawings. Valves in piping to and including 50 mm (2") dia. are to be ball type. All other shut-off valves are to be ball or butterfly type unless otherwise specified. Locate valves so they are easily accessible. Wherever possible, install valves at uniform height. Provide chain operators for valves which are inaccessible for operation from floor level.
- .7 Provide a check valve in discharge piping of every pump, and elsewhere in piping where shown on drawings. Where check valves are required in vertical piping, ensure they are suitable in all respects for the application. Check valves for vertical in-line and/or base mounted circulating pumps are integral with the discharge accessory.
- .8 Provide a drain valve at base of each piping riser, in drain connections to equipment, in low points of horizontal piping, and wherever else shown and/or specified.
- .9 Provide circuit balancing valves in piping generally where shown on drawings but with exact locations in accordance with instructions of personnel doing system flow balancing work. Confirm locations prior to installation.

### **3.03 INSTALLATION OF PRESSURE RELIEF VALVES**

- .1 Provide factory set pressure relief valves. Pipe discharge of each water piping relief valve to drain unless otherwise shown or specified.
- .2 Pipe discharge of each glycol solution piping relief valve back to system expansion tank or return piping.
- .3 Confirm relief valve settings.

### **3.04 INSTALLATION OF AIR VENTS**

- .1 Provide an air vent in piping mains at all high points, at equipment connections, and wherever else shown and/or specified. Equip each air vent with a ball type shut-off valve. Install vents in 100 mm (4") dia. and larger piping and all vents in mechanical rooms in accordance with drawing detail.
- .2 Provide 9 mm (3/8") dia. copper drain piping from each automatic air vent to nearest suitable drain and terminate so discharge is visible. Identify drain piping.

### **3.05 INSTALLATION OF STRAINERS**

- .1 Provide strainers in piping. Locate strainers so baskets are easily accessible and removable. Clean strainer baskets during and after piping system flushing and cleaning is complete, and before water quantity balancing commences.

### **3.06 INSTALLATION OF EXPANSION COMPENSATORS**

- .1 Provide expansion compensation in piping.
- .2 Generally, locate expansion compensation where shown, but with exact locations to suit piping as installed.
- .3 Provide double pipe alignment guides in horizontal piping at each side of expansion compensation facilities to permit movement in axial direction only. Secure guides to building structure only.
- .4 Provide a pipe guide at each side of expansion joints in vertical risers.

### **3.07 INSTALLATION OF PIPING ANCHORS**

- .1 Provide anchors to secure piping to structure. Locate anchors generally where shown but with exact locations to suit piping as installed and requirements of reviewed anchor shop drawings.
- .2 When installation of anchors is complete, arrange, and pay for anchor design engineer to visit site to review anchor installation. Submit a signed letter with engineer's stamp from design engineer confirming each anchor is properly installed.

### **3.08 INSTALLATION OF AIR SEPARATOR**

- .1 Provide an air separator in piping and connect with valved inlet and outlet piping.
- .2 Extend valved blowdown piping from bottom pipe connection tapping to nearest floor drain location.
- .3 Equip top pipe connection tapping with an automatic air vent, and piping as detailed.

### **3.09 INSTALLATION OF EXPANSION TANK**

- .1 Provide an expansion tank.
- .2 Secure horizontal expansion tank in place from structure by means of properly sized galvanized steel hanger rods and support saddles supplied with tank.
- .3 Connect tank with system piping. Extend a drain line from tank piping and terminate drain line with a drain valve. Provide an air vent.
- .4 Provide a water make-up connection line complete with relief valve and pressure gauge and connect to system piping. Terminate make-up piping for connection to domestic cold water piping as part of the work of Section entitled Domestic Water Piping and Valves. Check relief valve operation and adjust as required.
- .5 Check tank air charge and adjust to suit system.

### **3.10 INSTALLATION OF FLEXIBLE PIPING CONNECTIONS**

- .1 Provide flexible connections in piping connections to equipment.
- .2 Install in accordance with manufacturer's instructions.

**3.11 INSTALLATION OF CIRCULATING PUMPS**

- .1 Install horizontal inline pumps in place in vertical piping approximately 1.2 m (4') above floor in accordance with pump manufacturer's instructions.
- .2 If circulating pumps are used for piping flushing and cleaning, and pump seal flush line filters are not installed, replace pump mechanical seals when flushing and cleaning is complete.
- .3 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .5 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

**3.12 FLUSHING AND CLEANING PIPING**

- .1 Flush and clean new piping in accordance with requirements specified in Section entitled HVAC Water Treatment.

**3.13 TESTING, ADJUSTING AND BALANCING**

- .1 When work is complete and equipment is operating as intended, test, adjust and balance water flows in accordance with requirements specified in Section entitled Testing, Adjusting, and Balancing.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe and fittings.
- .2 Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed, approved, and signed by refrigeration equipment manufacturers prior to being submitted to Consultant for review.
- .3 Submit letters from equipment suppliers certifying proper installation and start-up of piping systems and equipment as specified in Part 3 of this Section.

### **1.02 QUALITY ASSURANCE**

- .1 Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.
- .2 Refrigerant piping installing contractor is to be certified by Technical Standards and Safety Authority (TSSA). Installing contractor is to install refrigerant piping in accordance with manufacturer's installation instructions and in accordance with local codes. Contractor is responsible for all regulatory approvals, if required. Upon completion of installation, documentation of refrigerant amount, test certificates and verification documentation, etc., is to be provided in a binder, in accordance with requirements of local authorities having jurisdiction.
- .3 Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

## **2 PRODUCTS**

### **2.01 PIPE, FITTINGS AND JOINTS**

- .1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, factory degreased, dehydrated and capped or nitrogen filled and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

### **2.02 GENERAL RE: VALVES AND PIPING SPECIALTIES**

- .1 Refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to site with capped ends.

### **2.03 SHUT-OFF VALVES**

- .1 Ball Valves
  - .1 ¼ turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, 2 O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into body, a ball position indicator on stem, and extended copper tube connections to permit brazing the valve into line without disassembling valve.

- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

.2 Diaphragm Valves

- .1 Forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering diaphragm chamber, one phosphor bronze and 2 stainless steel diaphragms, and extended copper tube brazing connections.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

**2.04 CHECK VALVES**

- .1 Straight through type for valves 6.4 mm to 16 mm (¼" to 5/8") diameter, globe type for valves 22 mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:
  - .1 straight through type check valves complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat;
  - .2 globe type check valves complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

**2.05 PIPING TRAPS**

- .1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.



## 2.06 PRESSURE VESSEL RELIEF VALVES

- .1 Factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

## 2.07 REFRIGERANT LIQUID MOISTURE INDICATORS

- .1 Forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in system, a plastic dust cover, and extended copper tube brazing connections.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

## 2.08 LIQUID LINE FILTER-DRIER

- .1 Mueller Industries Inc. "Drymaster" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

## 2.09 FLEXIBLE PIPING CONNECTIONS

- .1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends.
- .2 Acceptable manufacturers are:
  - .1 Senior Flexonics Canada;

.2 The Metraflex Co.

## **2.10 THERMOSTATIC EXPANSION VALVES**

- .1 Factory tested, balanced port design thermostatic expansion valves, with exact selection to suit the application and refrigerant used, each complete within a replaceable stainless steel diaphragm and welded element construction thermostatic element charged with hydraulic fluid, and removable inlet strainer.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

## **3 EXECUTION**

### **3.01 INSTALLATION OF REFRIGERANT PIPING, VALVES AND SPECIALTIES**

- .1 Provide required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this Section.
- .2 Make refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During brazing process, ensure pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside pipe and fitting.
- .3 Where shown or specified, use soft copper refrigerant piping line sets.
- .4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with equipment. Provide ball or diaphragm type shut-off valves inside building. Provide diaphragm shut-off valves outside building.
- .5 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with equipment.
- .6 Provide refrigerant piping accessories shown and/or required and install in accordance with manufacturer's recommendations.
- .7 Provide required refrigerant.
- .8 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with manufacturer's instructions.
- .9 Provide expansion valves where shown and/or required, each matched to coil and installed in accordance with manufacturer's instructions.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all water treatment chemical feed equipment and associated hardware.
- .2 Submit product literature sheets for all chemicals, as well as WHMIS Material Safety Data Sheets for all chemicals.
- .3 Submit water treatment manufacturer/supplier certification letters as specified in Part 3 of this Section.
- .4 Submit water treatment test sets and spare chemicals as specified below and in Part 3 of this Section.

## **2 PRODUCTS**

### **2.01 CHARACTERISTICS OF CHEMICALS AND SPARE CHEMICALS**

- .1 Chemicals specified in this Section are to be non-toxic when released to atmosphere, non-corrosive and non-staining if a leak occurs, and compatible with all system components.
- .2 Chemicals must be approved by governing authorities for release into Municipal sewer system.
- .3 For each treatment system for which chemicals are supplied, supply and hand to Owner, at Substantial Performance of the Work, spare chemical in original containers/packaging sufficient for 2 months of treatment system operation.

### **2.02 MANUFACTURERS/SUPPLIERS OF CHEMICALS AND FEED EQUIPMENT**

- .1 Acceptable manufacturers/suppliers are:
  - .1 Ashland Hercules Water Technologies;
  - .2 Klenzoid Inc.;
  - .3 Magnus Canada;
  - .4 Chem-Aqua Canada.

### **2.03 PIPING SYSTEM FLUSHING AND CLEANING CHEMICAL**

- .1 Liquid form alkaline type cleaner consisting of a concentrated blend of highly active penetrating agents and detergents with a 12.5 pH and specifically formulated to remove oil, mill scale and oxides from piping and equipment.

### **2.04 CLOSED HEAT TRANSFER SYSTEM TREATMENT**

- .1 Chemicals, chemical feed equipment, and test equipment to control corrosion in closed heat transfer circulating systems as indicated on drawings and as specified below.

- .2 Enamelled steel or cast iron by-pass feeders sized as shown, 2060 kPa (300 psi) rated and complete with 20 mm ( $\frac{3}{4}$ " ) diameter NPT pipe connection tappings, and a screw-on cast iron cap with "Buna N" "O" ring seal.
- .3 By-pass filter and flow indicator assembly equal to a Shelco Inc. FOS78, 1725 kPa (250 psi) rated replaceable cartridge filter assembly with a stainless steel housing and 20 mm ( $\frac{3}{4}$ " ) diameter piping connections, sized for approximately 5% of rated circulating pump flow and complete with a minimum of 6, 20 micron filter cartridges, and a sight flow indicator equal to an Anderson Midwest Model 350SS with 20 mm ( $\frac{3}{4}$ " ) diameter piping connections.
- .4 Piping tee mounting coupon holders, each complete with 25 mm (1") diameter NPT plugs with a minimum of one coupon for copper and one coupon for steel.
- .5 Chromate free, nitrite/borate type corrosion inhibitor suitable for use with both ferrous and non-ferrous metals.
- .6 Test kit for measuring inhibitor level.

## **2.05 BOILER BOIL-OUT CHEMICALS**

- .1 Boiler boil-out chemicals selected by chemical treatment manufacturer/ supplier in consultation with Consultant and boiler manufacturer, and chemicals selected must be approved by boiler manufacturer.

## **2.06 WATER TREATMENT TESTING COUNTER**

- .1 Factory made, 1.8 m (6') long, 915 mm (36") high, 600 mm (24") deep commercial grade counter assembly with toe space, complete with:
  - .1 at one end, a 508 mm x 520 mm x 175 mm (20" x 20- $\frac{1}{2}$ " x 7") type 316 stainless steel sink equal to a AMI #1017-C, complete with 3-hole punched ledgeback, crumb cup strainer, and a drain fitting with 40 mm (2- $\frac{1}{2}$ " ) dia. tailpiece;
  - .2 supply fitting equal to a Zurn #Z-831B4-lct-25 with vandal-proof aerator and 100 mm (4") long blade handles;
  - .3 acid-resistant counter surface with minimum 250 mm (10") high splashback;
  - .4 set of double doors under sink;
  - .5 set of 4 drawers at end opposite sink;
  - .6 cupboard with 3 adjustable shelves adjacent to drawers;
  - .7 all required hardware, including concealed hinges, drawer slides with stops, and door pulls;
  - .8 acid-resisting white enamel finish on all wooden surfaces.

### **3 EXECUTION**

#### **3.01 PIPING SYSTEM FLUSHING AND CLEANING**

- .1 After new heat transfer system piping has been installed and leakage testing has been satisfactorily completed, but before mechanical equipment start-up and performance tests, flush and chemically clean piping systems.
- .2 Provide required temporary piping connections, including bypass piping to isolate dirt sensitive mechanical plant equipment. Remove instrumentation such as flow meters and switches, orifice plates, meter valves and similar devices and plug pipe openings. Reinstall when flushing and cleaning work has been certified complete by chemical manufacturer/installer. Ensure control valves are operational and fully open during flushing and cleaning.
- .3 Prior to chemical cleaning, flush piping, including dead ends, with water to remove loose solids. Clean all strainers. Replace chemical feeder line filters as required. Flush and drain until water runs clear.
- .4 When flushing with water is complete, fill systems with fresh clean water. Meter amount of water required to fill each system or otherwise calculate system capacity. Ensure all air is vented from systems. Add cleaning chemical as instructed by chemical manufacturer and circulate solution for a period of time and at a temperature as required to produce a clean piping system. Conduct daily pH, conductivity, and total iron tests in accordance with chemical supplier's instructions.
- .5 After chemical cleaning when test results indicate a clean system, drain solution from piping, refill with clean water and circulate water for a minimum of 24 hours to flush out remaining chemical solution, then drain water from piping using all drain points and again clean all system strainers and replace filters. Arrange for chemical supplier to check each system after flushing and cleaning is complete and to certify in writing that flushing and cleaning procedures have been properly performed. Submit a copy of the certification letter. Fill systems.

#### **3.02 INSTALLATION OF CLOSED HEAT TRANSFER SYSTEM TREATMENT**

- .1 After flushing and cleaning procedures have been certified complete, provide a by-pass chemical feeder, a cartridge filter assembly, and corrosion test coupons for each closed heat transfer system. Install in accordance with requirements of drawing details.
- .2 Supply and feed into each system sufficient chemical to charge system to proper concentrations of chemical, and maintain proper levels in system until Substantial Performance of the Work.

#### **3.03 BOILER BOIL-OUT AND CLEANING**

- .1 When boiler installation is complete, inspect each boiler and remove all visible debris, rust, scale, and oil, then thoroughly flush each boiler with clean water. Provide required temporary piping connections.
- .2 When flushing is complete boil-out each boiler with a chemical solution approved by boiler manufacturer to remove remaining grease, oil, and dirt. Operate each boiler at 50% of normal operating pressure for a minimum of 48 hours or until all contaminants are removed, then again flush each boiler with fresh water until all traces of chemical solution are removed.

- .3 When boilers are clean and have been flushed, immediately fill each boiler with water which is chemically treated as specified in this Section.

### **3.04 INSTALLATION OF WATER TREATMENT TESTING COUNTER**

- .1 Provide a counter assembly with sink and trim for use during water treatment testing of circulating system samples. Confirm exact location prior to rough-in of services.
- .2 Store treatment test kits and a WHMIS Material Safety Data Sheet for each treatment chemical in the counter assembly.

### **3.05 MANUFACTURER'S CERTIFICATION, START-UP, AND TRAINING**

- .1 For all water treatment equipment include for on-site certification, start-up supervision, and system training by treatment chemical manufacturer's representative as follows:
  - .1 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements;
  - .2 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements;
  - .3 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.
- .2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.
- .3 With shop drawing/product data sheet submission, supply evidence that fire rated duct manufacturer is ULC listed to size requirements shows on drawings.
- .4 Submit duct leakage test data prior to ductwork being covered from view.
- .5 Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.
- .6 Submit proper installation certification from fire rated duct manufacturer as specified in Part 3 of this Section.
- .7 Supply and hand to Owner at Substantial Performance of the Work, a minimum of 10 identified (with tags) grille/diffuser volume control damper adjustment keys.

**1.02 QUALITY ASSURANCE**

- .1 Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

**2 PRODUCTS**

**2.01 GALVANIZED STEEL DUCTWORK**

- .1 Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.
- .2 Rectangular
  - .1 Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.

**2.02 ROUND ALUMINUM DUCTWORK**

- .1 Alloy 3003 Temper H14 aluminum, ASTM B209, factory fabricated, water-tight, smooth interior, single wall duct, and fittings of spiral lockseam construction with site sealed beaded sleeve (slip type) joints, all in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct working pressure classification, and type 316 stainless steel sheet metal screws and support hardware.

**2.03 FLEXIBLE METALLIC DUCTWORK**

- .1 Bare

- .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.
- .2 Insulated
  - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1-½") thick, 12 kg/m<sup>3</sup> (0.75 lb/ft<sup>3</sup>) density fibreglass insulation with a vinyl jacket meeting 25/50 flame spread and smoke developed requirements tested in accordance with CAN/ULC S102.

#### **2.04 FLEXIBLE CONNECTION MATERIAL**

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:
  - .1 Duro Dyne Canada Inc. "DUROLON";
  - .2 Dyn Air Inc. "HYPALON".
- .2 Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber. Acceptable products are:
  - .1 Duro-Dyne Canada Inc. "THERMAFAB";
  - .2 Dyn Air Inc. "SILICON HI-T".

#### **2.05 METAL DUCT SYSTEM JOINT SEALANT**

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.
- .2 Acceptable manufacturers are:
  - .1 Johns Manville;
  - .2 Manson Insulation;
  - .3 Knauf Insulation.

#### **2.06 ACOUSTIC LINING**

- .1 Minimum 25 mm (1") thick acoustic lining material meeting 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102, meeting NFPA 90A, ASTM C1071, and ASTM G21 requirements, not supporting microbial growth, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on inside (airside) face with a black fire-resistant coating.
- .2 Acceptable manufacturers are:



- .1 Johns Manville;
- .2 Manson Insulation;
- .3 Knauf Insulation.

## **2.07 CASING AND PLENUM MATERIAL AND ACCESSORIES**

- .1 Unless otherwise specified, casing and plenum material is to be same as connecting duct material.
- .2 Accessories such as access doors and drain pans are to be constructed of same material as casing and plenum and are to be in accordance with Chapter 6 of SMACNA HVAC

## **2.08 PLENUM ACCESS DOORS**

- .1 Factory fabricated, double wall insulated access doors, sized as indicated on drawings, and constructed of same material as connecting ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit operating pressure of the system.

## **2.09 ROUND TO RECTANGULAR DUCT CONNECTIONS**

- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

## **2.10 SPLITTER DAMPERS**

- .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to DynAir Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

## **2.11 AIR TURNING VANES**

- .1 For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections, air extractor type each equipped with a matching bottom operated 90° opposed blade volume control damper, constructed of same material as duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

## **2.12 MANUAL BALANCING (VOLUME) DAMPERS**

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:
  - .1 hexagonal or square shaft extension through frame;

- .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
  - .3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;
  - .4 linkage for multiple blade dampers;
  - .5 locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.
- .2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
  - .3 Round Dampers: Nailor Industries Inc. Model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
  - .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.
  - .5 Acceptable manufacturers are:
    - .1 Nailor Industries Inc.;
    - .2 T.A. Morrison & Co. Inc. "TAMCO";
    - .3 NCA Manufacturing Ltd.;
    - .4 Greenheck Fan Corp.;
    - .5 Ruskin Co.

### 2.13 BACKDRAFT DAMPERS

- .1 Nailor Industries Model 1370CB counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm (2") wide, sized as shown and complete with:
  - .1 extruded 6063-T5 aluminum frame, 2.3 mm (0.090") nominal wall thickness, with mitred corners;
  - .2 extruded 6063-T5 aluminum blades, 1.3 mm (0.050") nominal wall thickness on 92 mm (3-5/8") centres, and with extruded PVC blade seals;
  - .3 corrosion-resistant synthetic bearings;
  - .4 adjustable plated steel counterweights mounted internally in the airstream;
  - .5 concealed blade linkage located out of the airstream.
- .2 Acceptable manufacturers are:
  - .1 Nailor Industries Inc.;
  - .2 T.A. Morrison & Co. Inc. "TAMCO";

- .3 NCA Manufacturing Ltd.;
- .4 Greenheck Fan Corp.;
- .5 Ruskin Co.

#### **2.14 FUSIBLE LINK DAMPERS**

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.
- .3 Acceptable manufacturers are:
  - .1 Nailor Industries Inc.;
  - .2 Greenheck Fan Corp.;
  - .3 NCA Manufacturing Ltd.;
  - .4 Ruskin Co.;
  - .5 Price Industries (E.H. Price).

#### **2.15 ROOF DUCT SUPPORTS**

- .1 Equal to PHP Systems Design Model PHP-D adjustable duct support assemblies sized to suit duct size, each assembly complete with injection moulded recycled plastic and carbon black bases and tubular hot dip galvanized steel framing.

#### **2.16 PRESSURE RELIEF DOORS**

- .1 Greenheck model PRAD (positive) or VRAD (negative) pressure relief doors constructed of same material as duct or plenum they are associated with, each complete with a sealing gasket, special latches, cable assembly with spring to limit door opening to maximum 80° and factory set, field adjustable pressure relief magnet assembly.
- .2 Size access doors to match requirements of system so pressure drop through open blow-out door at required flow rate will not exceed rated pressure of duct system.
- .3 Acceptable manufacturers are:
  - .1 Greenheck Fan Corp.;
  - .2 United Enertech.

#### **2.17 DUCT ACCESS DOORS**

- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.

#### **2.18 DUCTWORK DRAIN POINTS**

- .1 Equal to Ductmate Canada Ltd. "Moisture Drain", 20 mm ( $\frac{3}{4}$ " ) diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.

#### **2.19 INSTRUMENT TEST PORTS**

- .1 Equal to Duro-Dyne of Canada Ltd. #IP1 or #IP2 (to suit insulation thickness where applicable) gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

#### **2.20 WIRE MESH (BIRDSCREEN)**

- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm ( $\frac{1}{2}$ " x  $\frac{1}{2}$ " ) secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.

#### **2.21 BRICK AND BLOCK VENTS**

- .1 Equal to Price Industries Inc. vents constructed of 6063-T5 alloy extruded aluminum, sized as shown, complete with stainless steel fasteners, aluminum rod vertical supports on minimum 300 mm (12") centres, #2 mesh fixed aluminum screen, and all required accessories to suit the application.
- .2 Vent(s) to be factory finished with a finish equal to a baked "Kynar 500-XL" colour coat and a clear coat over cleaned and primed metal with colour as selected from manufacturer's standard colour range.

#### **2.22 GRILLES AND DIFFUSERS**

- .1 Grilles and diffusers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.
- .2 Acceptable manufacturers are:
  - .1 Price Industries Inc.;
  - .2 Anemostat;
  - .3 Krueger Division of Air System Components Inc.;
  - .4 Titus;
  - .5 Nailor Industries Inc.;
  - .6 Tuttle & Bailey.

### **3 EXECUTION**

#### **3.01 CLEANLINESS REQUIREMENTS FOR HANDLING AND INSTALLATION OF DUCTWORK**

- .1 Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

### **3.02 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK**

- .1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.
- .3 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum". Flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.
- .4 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.
- .5 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
- .6 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.
- .7 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.
- .8 Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.
- .9 Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.
- .10 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by Consultant.

- .11 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.
- .12 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
- .13 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:
  - .1 ductwork outside building or otherwise exposed to the elements;
  - .2 fresh air intakes
  - .3 wherever else shown.
  - .4 Leakage testing is to be performed by the Testing, Adjusting and Balancing (TAB) agency in accordance with SMACNA HVAC Air Duct Leakage Test Manual and is to be witnessed by Consultant.
  - .5 Leakage test following ductwork:
    - .1 Supply ductwork;
    - .2 Return ductwork;
    - .3 Exhaust ductwork;
  - .6 Be responsible for following:
    - .1 preparing duct systems for leakage testing prior to installation of external insulation including capping duct runouts and provision of final tap-in for test equipment;
    - .2 schedule testing with TAB agency in advance, be present for all testing and ensure notice is given to Consultant so they may witness testing;
    - .3 resealing and/or replacement of defective ductwork;
    - .4 bearing all costs associated with retesting ductwork which has failed to pass leakage testing.
- .14 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.

- .15 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .16 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.
- .17 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.

### **3.03 INSTALLATION OF FLEXIBLE DUCTWORK**

- .1 Provide maximum 3 m (10') long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.
- .2 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.
- .3 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.
- .4 Do not penetrate fire barriers with flexible duct.

### **3.04 INSTALLATION OF ACOUSTIC LINING**

- .1 Provide acoustic lining in ductwork in locations as follows:
  - .1 wherever shown and/or specified on drawings;
  - .2 supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along duct and outward from box in all directions;
  - .3 all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

### **3.05 INSTALLATION OF CASINGS AND PLENUMS**

- .1 Provide required shop or site fabricated casings and plenums. Unless otherwise specified or shown, construct casings and plenums of same material as connecting duct system.
- .2 Construct and install casings and plenums in accordance with Chapter 6 of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit systems' pressure classification. Ensure plenums and casings secured to building structure are gasketed air-tight and equipped with angle reinforcing.

- .3 Provide drain pans with accessible trapped drains for fresh air intake plenums, and wherever else shown.

### **3.06 INSTALLATION OF CASING AND PLENUM ACCESS DOORS**

- .1 Provide access doors into all site or shop fabricated casings and plenums requiring access, and wherever shown.
- .2 Construct access doors to open in or out to suit positive and negative pressures of system.
- .3 Provide pitot tube openings in access doors where required for system air quantity balancing purposes.
- .4 Provide suitably sized, engraved, red-white laminated Lamacoid warning nameplates on access doors into casings and plenums where equipment is located, i.e. fans.

### **3.07 INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS**

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

### **3.08 INSTALLATION OF SPLITTER DAMPERS**

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on drawings. Install splitter dampers so they cannot vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

### **3.09 INSTALLATION OF TURNING VANES**

- .1 Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

### **3.10 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS**

- .1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

### **3.11 INSTALLATION OF BACKDRAFT DAMPERS**

- .1 Provide backdraft dampers.



- .2 Install and secure dampers so they cannot move or rattle.

### **3.12 INSTALLATION OF FUSIBLE LINK DAMPERS**

- .1 Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr.) is suitable for fire barrier it is associated with.
- .2 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .3 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.
- .4 Where size of fire barrier opening requires use of a sectionalized fire damper assembly, provide multiple fusible link dampers (sized to CAN/ULC S112) bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework.

### **3.13 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL**

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

### **3.14 INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS**

- .1 Supply supports for roof mounted ductwork.
- .2 Hand adjustable structural supports to roofing trade on roof for installation and flashing into roof construction as part of roofing work. Accurately mark exact locations and spacing of structural supports and supervise installation. Provide properly sized hot dip galvanized structural steel angles between structural supports and secure in place on support studs. Support ductwork on the angles and provide galvanized steel banding to secure ducts to the angles.

### **3.15 INSTALLATION OF PRESSURE RELIEF DOORS**

- .1 Provide pressure release access doors to prevent duct system explosion or implosion as a result of a duct obstruction, i.e. closed fire damper, which prevents normal air flow through the system. Size access doors in accordance with requirements of Part 2 of this Section.
- .2 Where pressure release doors are shown in suction ducts or plenums, mount access door assembly so door swings in and latch mechanism is on the inside of duct or plenum. If latch mechanism is not accessible, provide a standard access door at latch side of the pressure release access door for maintenance purposes.

- .3 Adjust each latch mechanism by means of the adjusting pin to suit static pressure of the particular system in accordance with latch mechanism manufacturer's instructions.

### **3.16 INSTALLATION OF DUCT ACCESS DOORS**

- .1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for review.
- .4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

### **3.17 INSTALLATION OF INSTRUMENTS TEST PORTS**

- .1 Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.
- .2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

### **3.18 INSTALLATION OF WIRE MESH (BIRDSCREEN)**

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.
- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.

### **3.19 INSTALLATION OF GRILLES AND DIFFUSERS**

- .1 Provide grilles and diffusers. Wherever possible, grilles and diffusers are to be product of same manufacturer.
- .2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Exactly locate grilles and diffusers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.
- .5 Confirm grille and diffuser finishes prior to ordering.

### **3.20 DUCT SYSTEM PROTECTION, CLEANING AND START-UP**

- .1 Temporarily cover all open ends of ducts during construction.
- .2 Remove all dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans.
- .3 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .4 Provide cheesecloth over duct system inlets and outlets and run system for 24 hours, after which remove cheesecloth and construction filters, and install new permanent filters.
- .5 Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted and balanced for the purpose of confirming proper position and attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for fans and accessories. Include following:
  - .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
  - .2 certified sound power data that conforms to specified levels;
  - .3 product data sheets for all accessories;
  - .4 product data sheets for fan motors.
- .2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

### **1.02 QUALITY ASSURANCE**

- .1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
  - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
  - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
  - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
  - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
  - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

## **2 PRODUCTS**

### **2.01 CENTRIFUGAL INLINE FANS**

- .1 Centrifugal, ULC listed, factory run tested rectangular inline fans in accordance with drawing schedule.
- .2 Heavy-gauge galvanized steel housing with removable side panels to permit removal of power assembly without disturbing duct connections, universal mounting brackets and hardware including spring vibration isolators to accommodate horizontal or vertical mounting as required, a flanged inlet panel with inlet venturi, a flanged outlet panel, both with duct connection collars, and galvanized steel wire grid fan inlet/outlet guard(s).
- .3 Non-overloading aluminium wheel with backward inclined blades with matching inlet venturi, statically and dynamically balanced as an assembly.

- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and heavy-duty, self-aligning pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours and equipped with lubrication line and fitting, and an adjustable V-belt drive with guard conforming to requirements of Section entitled Basic Mechanical Materials and Methods.
- .5 TEFC motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, mounted out of the airstream, complete with a cover, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 For fans as scheduled, factory supplied accessories as follows:
  - .1 for fans as scheduled, housing insulation (lining), consisting of neoprene spray coated glass fibre semi-rigid insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, permanently secured in place with no exposed edges;
  - .2 for fans as scheduled, a galvanized steel filter box with frame suitable for 25 mm (2") thick disposable panel type filters;
- .7 Acceptable manufacturers are:
  - .1 Loren Cook Co.;
  - .2 Greenheck Fan Corp.;
  - .3 Carnes Company Inc.

## 2.02 TOILET EXHAUST FANS

- .1 Equal to Zonex GM-3 ceiling exhaust fan, HVI certified, in accordance with the drawing schedule and following requirements:
  - .1 26-gauge galvanized steel housing supplied with vibration isolation to suit mounting;
  - .2 5" dia. Discharge collar with integral gravity backdraft damper;
  - .3 Field wiring compartment with integral disconnect receptacle;
  - .4 Galvanized steel, forward-curved blower wheel, dynamically balanced;
  - .5 Permanently-lubricated motor, plugin, 4-pole with automatic-reset thermal overload protection;
  - .6 Electrostatically-painted steel grille.

### **3 EXECUTION**

#### **3.01 INSTALLATION OF CENTRIFUGAL INLINE FANS**

- .1 Provide inline centrifugal fans.
- .2 Secure each fan in place from structure with vibration isolation, independent of connecting ductwork and in accordance with fan manufacturer's instructions.
- .3 Ensure duct connections are made using flexible connection material.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

#### **3.02 INSTALLATION OF TOILET EXHAUST FANS**

- .1 Provide toilet exhaust fans.
- .2 Install in accordance with manufacturer's instructions.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all products specified in this Section.
- .2 Prior to Substantial Performance of the Work, submit a set of spare filters in original identified packaging for each air handling unit requiring filters. Store filters on site where directed by Consultant or Owner.

**2 PRODUCTS**

**2.01 GENERAL**

- .1 Unless otherwise specified or noted, filters are to be synthetic and/or glass fibre disposable media type in accordance with drawing schedule(s).
- .2 Minimum Efficiency Reporting Values (MERV) ratings in accordance with ASHRAE Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Sizes.
- .3 Unless otherwise specified or noted, filters are to be ULC Class 1 in accordance with ULC S111, Standard Method of Fire Tests for Air Filter Units.
- .4 Acceptable manufacturers are:
  - .1 AAF International;
  - .2 Camfil Farr Inc.;
  - .3 Modern Air Filter Corp.

**2.02 CONSTRUCTION FILTERS**

- .1 Roll type, disposable, MERV 7 to 9 woven glass fibre media, ULC Class 2.

**2.03 DIAL TYPE AIR FILTER GAUGE**

- .1 Dwyer Instruments Inc. Series 2000 "Magnehelic" differential dial type filter gauge, accurate to within  $\pm 2\%$  of full scale and complete with a die-cast aluminum housing and bezel, acrylic cover, over-pressure relief plug, a pair of 3.2 mm (1/8") dia. female NPT pressure taps at both the side and back of gauge, 2 pressure tap plugs, flexible vinyl tubing, a scale overlay or marker to indicate dirty filters, and all other required mounting and connection accessories.

**3 EXECUTION**

**3.01 INSTALLATION OF CONSTRUCTION FILTERS**

- .1 Provide roll type medium efficiency disposable media filter(s) across entire filter bank of each supply air handling unit, either at factory where fan is produced or at site as soon as fan is installed. Secure media in place so it will not be dislodged by fan operation. Replace roll media periodically if it becomes loaded and clogged.

- .2 For exhaust systems, secure filter media across exhaust air openings and ductwork to prevent construction dirt and dust from fouling the fan
- .3 Leave media in place until fan start-up, at which time remove and dispose of construction media.

### **3.02 INSTALLATION OF FILTERS**

- .1 Provide required filter media when fan equipment is ready for start-up and performance testing. Provide any required filter framing/racks.
- .2 Prior to Substantial Performance of the Work, supply a complete spare set of filter media in original packaging and clearly identified as to the applicable system for each air handling system with filters. Store filters at site where directed by Owner.

### **3.03 INSTALLATION OF DIAL TYPE FILTER GAUGES**

- .1 Provide dial type filter gauges for air handling system filter banks.
- .2 Secure gauge to filter section casing and install differential pressure tubing and accessories. Set gauges to suit fresh clean filter media and mark scales at point where filter media requires replacement.

**END OF SECTION**



**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit product data sheets for flue gas vents/air intakes and accessories.
- .2 Supply a reviewed shop drawing to appropriate trade to indicate vent size and flashing materials supplied, and accurately locate building openings.

**2 PRODUCTS**

**2.01 CONDENSING APPLIANCE TYPE BH FLUE GAS VENTS (AND COMBUSTION AIR INTAKES)**

- .1 Equal to Ipex "System 636" PVC (for vent gas to 65°C [130°F]) or CPVC (for vent gas to 90°C [195°F]) solvent weld vent pipe and fittings, in accordance with CAN/CSA B149.1, certified as type BH vents to ULC S636, Standard for Type BH Gas Venting Systems, suitable for negative or positive venting and complete with an orange warning label to verify compliance with ULC S636, and a moulded cap with screen for vertical termination, or low profile wall termination kit, as applicable.

**3 EXECUTION**

**3.01 INSTALLATION OF TYPE BH FLUE GAS VENTS (AND COMBUSTION AIR INTAKES)**

- .1 Provide type BH flue gas vents and combustion air intakes for condensing appliances.
- .2 Support spacing is to be in accordance with flue gas vent manufacturer's instructions. Installation is to be in accordance with gas fired appliance manufacturer's instructions and requirements of CAN/CSA B149.1.
- .3 Route piping using shortest route possible to termination point while avoiding interference with other work. Slope vent piping for positive drainage.
- .4 Equip termination of vent with a turn-down elbow with open end covered with bronze insect screen. Terminate exhaust vent a minimum of 3 m (10') away from fresh air intakes and operable windows.
- .5 Confirm flue gas vent diameter prior to ordering.

**END OF SECTION**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for boilers, including accessories, and all required wiring schematics. Include boiler flue product data sheets with the submission.
- .2 Submit manufacturer's 8 year extended warranty for the heat exchanger, and 2 year extended warranty for all other boiler components.
- .3 Supply complete spare charge of calcium carbonate chips for each acid neutralizing assembly.
- .4 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this Section.
- .5 Submit boiler manufacturer/supplier start-up and installation certification letters as specified in Part 3 of this Section.

**1.02 QUALITY ASSURANCE**

- .1 Boilers and installation of boilers are to be in accordance with requirements of following:
  - .1 all applicable Provincial Codes and Standards;
  - .2 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code;
  - .3 CAN/CSA B149.1, Natural Gas and Propane Installation Codes;
  - .4 CAN1-3.1, Industrial and Commercial Gas-Fired Package Boilers.
- .2 Boiler installation tradesmen are to be journeyman tradesmen licensed to install boiler equipment.

**2 PRODUCTS**

**2.01 HOT WATER BOILERS**

- .1 Lochinvar KNIGHT "KHB285" factory assembled hot water boilers in accordance with drawing schedule.
- .2 Performance requirements are as follows:
  - .1 The **BOILER** shall be capable of following performance:

Model	Turndown	Minimum Input	Maximum Input
KHB285	10:1	28,500	285,000

- .2 The **BOILER** shall bear the ASME "H" stamp for 80 psi working pressure and shall be National Board listed. The **BOILER** shall have a fully welded, stainless steel, fire tube heat exchanger. There shall be no banding material, bolts, gaskets or "O" rings in the pressure vessel construction. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. The condensate collection basin shall be constructed of welded stainless steel. The complete heat exchanger assembly shall carry a twelve (15) year limited warranty.

- .3 The heat exchanger shall have a volume of water no less than:

Model	Water Content
KHB285	4.9 gallons

- .4 The **BOILER** shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard. The **BOILER** shall operate at a minimum of 95% AFUE Efficiency (KHB/WHB055-285) and 94.4% THERMAL Efficiency (WHB399) as registered with AHRI. The **BOILER** shall be certified for indoor installation.
- .5 The **BOILER** shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber. The burner shall be a premix design constructed of high temperature stainless steel with a woven Feccralloy outer covering to provide smooth operation at all modulating firing rates. The **BOILER** shall be supplied with a negative pressure regulation gas valve and be equipped with a pulse width modulation blower system to precisely control the fuel/air mixture to the burner. The **BOILER** shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.
- .6 The **BOILER** shall utilize a 24 VAC control circuit and components. The control system shall have a factory installed display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The **BOILER** shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 30 psi (standard); outlet water temperature sensor with a dual thermistor to verify accuracy; system supply water temperature sensor; outdoor air sensor, flue temperature sensor with dual thermistor to verify accuracy; low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.

- .7 The **BOILER** shall feature the “SMART SYSTEM™” control which is standard and factory installed with 128 x 128 resolution display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities, USB drive for simple uploading of parameters and a PC port connection for connection to a local computer for programming and trending. A secondary operating control that is field mounted outside or inside the appliance is not acceptable. The **BOILER** shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The **BOILER** shall have a built-in “Cascade” with leader redundancy to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal “Cascade” function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The **BOILER** shall be capable of remote communication via optional CON-X-US™ Remote Connectivity with the capability of historical trending and sending text message or email alerts to notify the caretaker of a boiler alarm and remote programming of onboard boiler control. The control must have optional capability to communicate via Modbus protocol with a minimum of 46 readable points. The **BOILER** shall have an optional gateway device which will allow integration with LON or BacNet protocols.
- .8 The “SMART SYSTEM™” control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump (pump shall be supplied by manufacturer) to keep a fixed Delta T across the boiler regardless of the modulation rate. The **BOILER** shall have the capability to receive a 0-10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.
- .9 The **BOILER** shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 46 connection points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Low Water Cut Off, Louver Proving Switch, Tank Thermostat, Domestic Hot Water Building Recirculation Pump Contacts, Domestic Hot Water Building Recirculation Temperature Sensor Contacts, Remote Enable/Disable, System Supply Temperature Sensor, Outdoor Temperature Sensor, Tank Temperature Sensor, Modbus Building Management System Signal and Cascade Control Circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on all models. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.
- .3 The **BOILER** shall be installed and vented with:
  - .1 **Vertical roof top termination, complete with concentric vent kit.** The flue shall be Category IV approved material constructed of PVC, CPVC, Polypropylene or Stainless Steel. The boiler’s total combined air intake length shall not exceed 100 equivalent feet. The boiler’s total combined exhaust venting length shall not exceed 100 equivalent feet. The air inlet must terminate on the rooftop with the exhaust.

- .2 The **BOILER** shall have an independent laboratory rating for Oxides of Nitrogen (NO<sub>x</sub>) to meet the requirements of South Coast Air Quality Management District in Southern California and the requirements of Texas Commission on Environmental Quality. The manufacturer shall verify proper operation of the burner, all controls and the integrity of the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
- .3 The **BOILER** shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments. The **BOILER** shall be certified for operation at elevations of 4,500 feet, and above, by a 3<sup>rd</sup> party organization.

#### .4 **STANDARD CONSTRUCTION**

- .1 The **BOILER** shall be constructed in accordance with the following code requirements as standard equipment. Manufacturing of special models to meet the below code requirements is not acceptable

### **3 EXECUTION**

#### **3.01 INSTALLATION OF BOILERS**

- .1 Provide hot water boiler.
- .2 Move boiler into position, remove casters, and secure boiler in place, level, and plumb, on neoprene-steel-neoprene vibration isolation pads on a concrete housekeeping pad.
- .3 Connect boiler with piping and flue.
- .4 Install condensate acid neutralizers adjacent to boilers and connect with piping from boilers to neutralizers and from neutralizers to drain in accordance with manufacturer's directions and drawing requirements.
- .5 Install control components shipped loose for each boiler, including low water cut-offs, relief valve, and flow switch. Unless otherwise instructed, follow manufacturer's installation instructions. Provide pressure gauges and thermometers in boiler water supply and return piping connections.
- .6 Wall mount control panel where shown but confirm exact location prior to installation.
- .7 Perform required control wiring in conduit to connect control components. Follow boiler manufacturer's control wiring schematics and conduit and conductor installation requirements specified as part of electrical work.
- .8 When boiler plant installation is substantially complete, but prior to start-up, and prior to flushing and cleaning heating piping system as specified in Section entitled HVAC Water Treatment, inspect boiler and remove visible dirt, oil and debris, then cooperate with the boiler boil-out chemical supplier to ensure proper boil-out procedures are followed.
- .9 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .10 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

- .11 Include for a one day on-site boiler plant operation demonstration and training session. Training is to be a full review of all components including but not limited to a full boiler internal inspection, construction details, burner operation, maintenance, flame characteristics, and adjustments, gas train maintenance, boiler normal operation, abnormal events, normal shut-down, emergency shut-down, and setting up controls.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for all packaged rooftop units. Include following:
  - .1 certified fan performance curves;
  - .2 certified sound power data;
  - .3 dimensioned layouts, including dimensioned curb layouts as applicable;
  - .4 product data for fan motors.
- .2 Submit with delivery of each furnace a copy of the factory inspection and fire test report as specified in Part 2 of this Section, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Submit spare air filters as specified in Part 2 of this Section.

### **1.02 QUALITY ASSURANCE**

- .1 Packaged rooftop units and installation are to be in accordance with requirements of following:
  - .1 all applicable Provincial Codes and Standards;
  - .2 CAN/CSA B149, Natural Gas and Propane Installation Codes;
  - .3 CSA or ETL listed and labelled electrical components.
- .2 Packaged rooftop unit installation tradesmen are to be journeyman and licensed gas fitters.
- .3 Acceptable manufacturers are:
  - .1 Carrier;
  - .2 Trane;
  - .3 Lennox;
  - .4 York.

## **2 PRODUCTS**

### **2.01 PACKAGED ROOFTOP UNIT**

- .1 General

- .1 Outdoor, rooftop mounted, electrically controlled, heating and cooling unit utilizing a fully hermetic scroll compressor(s) for cooling duty and gas combustion for heating duty.
- .2 Factory assembled, single-piece heating and cooling rooftop unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and special features required prior to field start-up.
- .3 Unit shall use environmentally sound, puron refrigerant.
- .4 Unit shall be installed in accordance with the manufacturer's instructions.
- .5 Unit must be selected and installed in compliance with local, state, and federal codes.
- .2 Quality Assurance
  - .1 Unit meets ASHRAE 90.1 minimum efficiency requirements.
  - .2 Units are Energy Star certified where sizes are required.
  - .3 Unit shall be rated in accordance with AHRI Standard 340/360.
  - .4 Unit shall be designed to conform to ASHRAE 15.
  - .5 Unit shall be ETL-tested and certified in accordance with ANSI Z21.47 Standards and ETL-listed and certified under Canadian standards as a total package for safety requirements.
  - .6 Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
  - .7 Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).
  - .8 Unit casing shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 5000-hour salt spray.
  - .9 Unit shall be designed and manufactured in accordance with ISO 9001.
  - .10 Roof curb shall be designed to conform to NRCA Standards.
  - .11 Unit shall be subjected to a completely automated run test on the assembly line. The data for each unit will be stored at the factory, and must be available upon request.
  - .12 Unit shall be designed in accordance with UL Standard 1995, including tested to withstand rain.
  - .13 Unit shall be constructed to prevent intrusion of snow and tested to prevent snow intrusion into the control box up to 40 mph.
  - .14 Unit shake tested to assurance level 1, ASTM D4169 to ensure shipping reliability.
  - .15 High Efficient Motors listed shall meet section 313 of the Energy Independence and Security Act of 2007 (EISA 2007).



.3 Delivery, Storage, and Handling

- .1 Unit shall be stored and handled per manufacturer's recommendations.
- .2 Lifted by crane requires either shipping top panel or spreader bars.
- .3 Unit shall only be stored or positioned in the upright position.

.4 Operating Characteristics

- .1 Unit shall be capable of starting and running at 115\_F (46\_C) ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 340/360 at  $\pm 10\%$  voltage.
- .2 Compressor with standard controls shall be capable of operation down to 30\_F (-1\_C), ambient outdoor temperatures. Accessory winter start kit is necessary if mechanically cooling at ambient temperatures below 30\_F (-1\_C).
- .3 Unit shall discharge supply air vertically or horizontally as shown on contract drawings.
- .4 Unit shall be factory configured and ordered for vertical supply & return configurations.
- .5 Unit shall be factory furnished for either vertical or horizontal configuration without the use of special conversion kits. No field conversion is possible.

.5 Electrical Requirements

- .1 Main power supply voltage, phase, and frequency must match those required by the manufacturer.

.6 Unit Cabinet

- .1 Unit cabinet shall be constructed of galvanized steel, and shall be bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
- .2 Unit cabinet exterior paint shall be: film thickness, (dry) 0.003 inches minimum, gloss (per ASTM D523, 60\_F / 16\_C): 60, Hardness: H-2H Pencil hardness.
- .3 Evaporator fan compartment interior cabinet insulation shall conform to AHRI Standard 340/360 minimum exterior sweat criteria. Interior surfaces shall be insulated with a minimum 1/2-in. thick, 1 lb density, flexible fiberglass insulation, neoprene coated on the air side. Aluminum foil-faced fiberglass insulation shall be used in the gas heat compartment.
- .4 Base of unit shall have a minimum of four locations for thru-the-base gas and electrical connections standard. Both gas and electric connections shall be internal to the cabinet to protect from environmental issues.
- .5 Base Rail
  - .1 Unit shall have base rails on a minimum of 2 sides.

- .2 Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
- .3 Holes shall be provided in the base rail for moving the rooftop by fork truck.
- .4 Base rail shall be a minimum of 16 gauge thickness.
- .6 Condensate pan and connections
  - .1 Shall be a sloped condensate drain pan made of a non-corrosive material.
  - .2 Shall comply with ASHRAE Standard 62.
  - .3 Shall use a 3/4-in -14 NPT drain connection, through the side of the drain pan. Connection shall be made per manufacturer's recommendations.
- .7 Top panel:
  - .1 Shall be a multi-piece top panel linked with water tight flanges and locking systems.
- .8 Gas Connections:
  - .1 All gas piping connecting to unit gas valve shall enter the unit cabinet at a single location on side of unit (horizontal plane).
  - .2 Thru-the-base capability
    - .1 Standard unit shall have a thru-the-base gas-line location using a raised, embossed portion of the unit basepan.
    - .2 Thru-the-base provisions/connections are available as standard with every unit. When bottom connections are required, field furnished couplings are required.
    - .3 No basepan penetration, other than those authorized by the manufacturer, is permitted.
- .9 Electrical Connections
  - .1 All unit power wiring shall enter unit cabinet at a single, factory-prepared, knockout location.
  - .2 Thru-the-base capability.
    - .1 Thru-the-base provisions/connections are available as standard with every unit. When bottom connections are required, field furnished couplings are required.
    - .2 No basepan penetration, other than those authorized by the manufacturer, is permitted.
- .10 Component access panels (standard)
  - .1 Cabinet panels shall be easily removable for servicing.

- .2 Unit shall have one factory installed, tool-less, removable, filter access panel.
  - .3 Panels covering control box and filter shall have molded composite handles while the blower access door shall have an integrated flange for easy removal.
  - .4 Handles shall be UV modified, composite. They shall be permanently attached, and recessed into the panel.
  - .5 Screws on the vertical portion of all removable access panel shall engage into heat resistant, molded composite collars.
  - .6 Collars shall be removable and easily replaceable using manufacturer recommended parts.
- .7 Gas Heat
- .1 General
    - .1 Heat exchanger shall be an induced draft design. Positive pressure heat exchanger designs shall not be allowed.
    - .2 Shall incorporate a direct-spark ignition system and redundant main gas valve.
    - .3 Gas supply pressure at the inlet to the rooftop unit gas valve must match that required by the manufacturer.
  - .2 The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor.
    - .1 IGC board shall notify users of fault using an LED (light-emitting diode).
    - .2 The LED shall be visible without removing the control box access panel.
    - .3 IGC board shall contain algorithms that modify evaporator-fan operation to prevent future cycling on high temperature limit switch.
    - .4 Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high temperature limit switch. Fault indication shall be made using an LED.
  - .3 Standard Heat Exchanger construction
    - .1 Heat exchanger shall be of the tubular-section type constructed of a minimum of 20-gauge steel coated with a nominal 1.2 mil aluminum-silicone alloy for corrosion resistance.
    - .2 Burners shall be of the in-shot type constructed of aluminum-coated steel.
    - .3 Burners shall incorporate orifices for rated heat output up to 2000 ft (610m) elevation. Additional accessory kits may be required for applications above 2000 ft (610m) elevation, depending on local gas supply conditions.
    - .4 Each heat exchanger tube shall contain multiple dimples for increased heating effectiveness.

- .4 Induced draft combustion motor and blower
  - .1 Shall be a direct-drive, single inlet, forward-curved centrifugal type.
  - .2 Shall be made from steel with a corrosion-resistant finish.
  - .3 Shall have permanently lubricated sealed bearings.
  - .4 Shall have inherent thermal overload protection.
  - .5 Shall have an automatic reset feature.
- .8 Coils
  - .1 Standard Aluminum Fin - Copper Tube Coils:
    - .1 Standard evaporator and condenser coils shall have aluminum lanced plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
    - .2 Evaporator coils shall be leak tested to 150 psig, pressure tested to 450 psig, and qualified to UL 1995 burst test at 1775 psig.
    - .3 Condenser coils shall be leak tested to 150 psig, pressure tested to 650 psig, and qualified to UL 1995 burst test at 1980 psig.
- .9 Refrigerant Components
  - .1 Refrigerant circuit shall include the following control, safety, and maintenance features:
    - .1 Fixed orifice metering system shall prevent mal-distribution of two-phase refrigerant by including multiple fixed orifice devices in each refrigeration circuit. Each orifice is to be optimized to the coil circuit it serves.
    - .2 Refrigerant filter drier - Solid core design.
    - .3 Service gauge connections on suction and discharge lines.
      - .1 Pressure gauge access through a specially designed access screen on the side of the unit.
  - .2 Compressors
    - .1 Unit shall use fully hermetic, scroll compressor for each independent refrigeration circuit.
    - .2 Models shall be available with 2 compressor/2-stage cooling.
    - .3 Compressor motors shall be cooled by refrigerant gas passing through motor windings.
    - .4 Compressors shall be internally protected from high discharge temperature conditions.

- .5 Compressors shall be protected from an over-temperature and over-amperage conditions by an internal, motor overload device.
  - .6 Compressor shall be factory mounted on rubber grommets.
  - .7 Compressor motors shall have internal line break thermal, current overload and high pressure differential protection.
  - .8 Crankcase heaters shall not be required for normal operating range, unless provided by the factory.
- .10 Filter Section
- .1 Filters access is specified in the unit cabinet section of this specification.
  - .2 Filters shall be held in place by a preformed, slide-out filter tray, facilitating easy removal and installation.
  - .3 Shall consist of factory-installed, low velocity, throw-away 2-in. thick fiberglass filters.
  - .4 Filters shall be standard, commercially available sizes.
  - .5 Only one size filter per unit is allowed.
  - .6 4-in filter capability is possible with a field installed pre engineered slide out filter track accessory. 4-in filters are field furnished.
- .11 Evaporator Fan and Motor
- .1 Evaporator fan motor:
    - .1 Shall have inherent automatic-reset thermal overload protection or circuit breaker.
    - .2 Shall have a maximum continuous bhp rating for continuous duty operation; no safety factors above that rating shall be required.
  - .2 Belt-driven Evaporator Fan:
    - .1 Belt drive shall include an adjustable-pitch motor pulley and belt break protection system.
    - .2 Shall use rigid pillow block bearing system with lubricant fittings at accessible bearing or lubrication line.
    - .3 Blower fan shall be double-inlet type with forward-curved blades.
    - .4 Shall be constructed from steel with a corrosion resistant finish and dynamically balanced.
- .12 Condenser Fans and Motors
- .1 Condenser fan motors:
    - .1 Shall be a totally enclosed motor.

- .2 Shall use permanently lubricated bearings.
- .3 Shall have inherent thermal overload protection with an automatic reset feature.
- .4 Shall use a shaft-down design.
- .2 Condenser Fans:
  - .1 Shall be a direct-driven propeller type fan.
  - .2 Shall have galvalum blades riveted to corrosion-resistant steel spiders and shall be dynamically balanced.
- .13 Insulation
  - .1 Evaporator fan compartment:
    - .1 Interior cabinet surfaces shall be insulated with a minimum 1/2-in. thick, minimum 1 1/2 lb density, flexible fiberglass insulation bonded with a phenolic binder, neoprene coated on the air side.
    - .2 Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
  - .2 Gas heat compartment:
    - .1 Aluminum foil-faced fiberglass insulation shall be used.
    - .2 Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
- .14 Electric and Electronic Control System
  - .1 General:
    - .1 Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-v transformer side. Transformer shall have 75VA capability.
    - .2 Shall utilize color-coded wiring.
    - .3 Shall include a central control terminal board to conveniently and safely provide connection points for vital control functions such as: smoke detectors, phase monitor, gas controller, economizer, thermostat, DDC control options, and low and high pressure switches.
    - .4 The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor. See heat exchanger section of this specification.
    - .5 Unit shall include a minimum of one 8-pin screw terminal connection board for connection of control wiring.
  - .2 Safeties:
    - .1 Compressor over-temperature, over-current. High internal pressure differential.

- .2 Low-pressure switch.
  - .1 Units shall have different sized connectors for the circuit 1 and circuit 2 low and high pressure switches. They shall physically prevent the cross-wiring of the safety switches between circuits 1 and 2.
  - .2 Low pressure switch shall use different color wire than the high pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
- .3 High-pressure switch.
  - .1 Units shall have different sized connectors for the circuit 1 and circuit 2 low and high pressure switches. They shall physically prevent the cross-wiring of the safety switches between circuits 1 and 2.
  - .2 High pressure switch shall use different color wire than the low pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
- .4 Automatic reset, motor thermal overload protector.
- .5 Heating section shall be provided with the following minimum protections:
  - .1 High-temperature limit switches.
  - .2 Induced draft motor speed sensor.
  - .3 Flame rollout switch.
  - .4 Flame proving controls.
- .15 Panel Air Filters
  - .1 Standard filter section
    - .1 Shall consist of factory-installed, low velocity, disposable 2-in. thick fiberglass filters of commercially available sizes.
    - .2 Unit shall use only one filter size. Multiple sizes are not acceptable.
    - .3 Filters shall be accessible through a dedicated, weather tight access panel.
    - .4 4-in filter capabilities shall be capable with pre-engineered and approved Carrier filter track field installed accessory. This kit requires field furnished filters.
- .16 Special Features Options and Accessories
  - .1 Staged Air Volume System (SAV) for 2-stage cooling models only:
    - .1 Evaporator fan motor:
      - .1 Shall have permanently lubricated bearings.

- .2 Shall have a maximum continuous bhp rating for continuous duty operation; no safety factors above that rating.
  - .3 Shall be Variable Frequency duty and 2-speed control.
  - .4 Shall contain motor shaft grounding ring to prevent electrical bearing fluting damage by safely diverting harmful shaft voltages and bearing currents to ground.
- .2 Variable Frequency Drive (VFD). Only available on 2-speed indoor fan motor option (SAV):
- .1 Shall be installed inside the unit cabinet, mounted, wired and tested.
  - .2 Shall contain Electromagnetic Interference (EMI) frequency protection.
  - .3 Insulated Gate Bi-Polar Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform, allowing for quiet motor operation.
  - .4 Self diagnostics with fault and power code LED indicator. Field accessory Display Kit available for further diagnostics and special setup applications.
  - .5 RS485 capability standard.
  - .6 Electronic thermal overload protection.
  - .7 5% swinging chokes for harmonic reduction and improved power factor.
  - .8 All printed circuit boards shall be conformal coated.
- .3 Standard Integrated Economizers (Factory installed on 3 Phase Models Only. Field installed on all 3 and 1 Phase Models):
- .1 Integrated, gear-driven opposing blade design type capable of simultaneous economizer and compressor operation.
  - .2 Independent modules for vertical or horizontal return configurations shall be available. Vertical and horizontal return modules shall be available as a factory installed option.
  - .3 Damper blades shall be galvanized steel with composite gears. Plastic or composite blades on intake or return shall not be acceptable.
  - .4 Shall include all hardware and controls to provide free cooling with outdoor air when temperature and/or humidity are below setpoints.
  - .5 Shall be equipped with gear driven dampers for both the outdoor ventilation air and the return air for positive air stream control.
  - .6 Standard models shall be equipped with low-leakage dampers, not to exceed 2% leakage at 1 in. wg pressure differential. Economizer controller on electromechanical units shall be Honeywell W7212 that provides:
    - .1 Combined minimum and DCV maximum damper position potentiometers with compressor staging relay.



- .2 Functions with solid state analog enthalpy or dry bulb changeover control sensing.
- .3 Contain LED indicates for:
  - .1 When free cooling is available
  - .2 When module is in DCV mode
  - .3 When exhaust fan contact is closed
- .7 Shall be capable of introducing up to 100% outdoor air.
- .8 Shall be equipped with a barometric relief damper capable of relieving up to 100% return air.
- .9 Shall be designed to close damper(s) during loss-of-power situations with spring return built into motor.
- .10 Dry bulb outdoor air temperature sensor shall be provided as standard. Outdoor air sensor setpoint shall be adjustable and shall range from 40 to 100\_F / 4 to 38\_C. Additional sensor options shall be available as accessories.
- .11 The economizer controller shall also provide control of an accessory power exhaust unit function. Factory set at 100%, with a range of 0% to 100%.
- .12 The economizer shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy. A remote potentiometer may be used to override the damper setpoint.
- .13 Dampers shall be completely closed when the unit is in the unoccupied mode.
- .14 Economizer controller shall accept a 2-10 Vdc CO2 sensor input for IAQ/DCV control. In this mode, dampers shall modulate the outdoor air damper to provide ventilation based on the sensor input.
- .15 Compressor lockout sensor shall open at 35\_F (2\_C) and close closes at 50\_F (10\_C).
- .16 Actuator shall be direct coupled to economizer gear. No linkage arms or control rods shall be acceptable.
- .17 Economizer controller shall provide indications when in free cooling mode, in the DCV mode, or the exhaust fan contact is closed.
- .4 Unit-Mounted, Non-Fused Disconnect Switch:
  - .1 Switch shall be factory-installed, internally mounted.
  - .2 National Electric Code (NEC) and UL approved non-fused switch shall provide unit power shutoff.
  - .3 Shall be accessible from outside the unit.
  - .4 Shall provide local shutdown and lockout capability.

- .5 Centrifugal Power Exhaust:
  - .1 Power exhaust shall be used in conjunction with an integrated economizer.
  - .2 Independent modules for vertical or horizontal return configurations shall be available.
  - .3 Horizontal power exhaust is shall be mounted in return ductwork.
  - .4 Power exhaust shall be controlled by economizer controller operation. Exhaust fans shall be energized when dampers open past the 0-100% adjustable setpoint on the economizer control.
- .6 Factory-Installed Non-Powered convenience outlet
  - .1 Outlet shall be powered from a separate 115/120v power source.
  - .2 Outlet shall be factory-installed and internally mounted with easily accessible 115-v female receptacle.
  - .3 Outlet shall include 15 amp GFI receptacles with independent fuse protection.
  - .4 Outlet shall be accessible from outside the unit.
  - .5 Outlet shall include a field installed "Wet in Use" cover.
- .7 Roof Curbs:
  - .1 Full perimeter roof curb with exhaust capability providing separate air streams for energy recovery from the exhaust air without supply air contamination.
  - .2 Formed galvanized steel with wood nailer strip and shall be capable of supporting entire unit weight.
  - .3 Permits installation and securing of ductwork to curb prior to mounting unit on the curb.
- .8 Outdoor Air Enthalpy Sensor:
  - .1 The outdoor air enthalpy sensor shall be used to provide single enthalpy control. When used in conjunction with a return air enthalpy sensor, the unit will provide differential enthalpy control. The sensor allows the unit to determine if outside air is suitable for free cooling.
- .9 Return Air Enthalpy Sensor:
  - .1 The return air enthalpy sensor shall be used in conjunction with an outdoor air enthalpy sensor to provide differential enthalpy control.
- .10 Indoor Air Quality (CO2) Sensor:
  - .1 Shall be able to provide demand ventilation indoor air quality (IAQ) control.
  - .2 The IAQ sensor shall be available in duct mount, wall mount, or wall mount with LED display. The setpoint shall have adjustment capability.

**3 EXECUTION**

**3.01 INSTALLATION OF PACKAGED ROOFTOP UNIT**

- .1 Provide gas fired rooftop units on roof.
- .2 Provide required rigging and hoisting/moving equipment required to move each unit to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details
- .3 Locate curbs on roof where required for installation and flashing into roof construction as part of roofing work of Division 07. Secure units in place, level, and plumb, on gasketing material.
- .4 Remove fan base hold-down clamps and other shipping restraints and protective packaging.
- .5 Install components shipped loose with units. Install in accordance with manufacturer's recommendations. Calibrate control components requiring field calibration.
- .6 Extend condensate trapped drains using schedule 40 galvanized steel piping to roof.
- .7 Provide thermostats and wall mount on a recessed box. Confirm exact locations prior to roughing-in. Connect complete with 24 volt control wiring in conduit to standards of electrical work and manufacturer's certified wiring diagram. Set-up and program thermostats in accordance with owner's requirements.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.
- .2 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this Section.
- .3 Prepare and submit a schematic layout of refrigerant piping showing all piping components required for satisfactory operation and maintenance of the system(s), including but not limited to pipe sizes, charging valve, isolating valves, sight glasses, strainers, driers, traps, etc. Schematic diagram must be reviewed with and approved by air conditioning equipment supplier prior to submittal to Consultant.

### **1.02 QUALITY ASSURANCE**

- .1 Split system air conditioning equipment and installation of equipment are to be in accordance with requirements of following:
  - .1 all applicable Provincial Codes and Standards;
  - .2 ANSI/AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .2 Split system air conditioning system installation tradesmen are to be journeyman refrigeration mechanics.

## **2 PRODUCTS**

### **2.01 SPLIT SYSTEM AIR CONDITIONING EQUIPMENT**

- .1 Factory assembled and tested, package type equipment consisting of an indoor evaporator unit and an exterior condensing unit in accordance with drawing schedule, CSA or ETL listed and labelled, AHRI rated and certified and with a minimum system efficiency of 13 SEER.
- .2 Wall mounting evaporator assembly consisting of a white moulded high-strength plastic cabinet with front access panel, a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction and which closes when fan operation is stopped, motorized vertical vanes controlled remotely, and a mounting plate supplied loose. Evaporator complete with:
  - .1 double inlet, forward curve fan(s) direct driven by a single 4-speed motor;
  - .2 removable and washable return air filter;
  - .3 factory pressure tested multi-angled coil of non-ferrous construction with aluminium fins, copper tubes with silver alloy solder joints, and an insulated condensate drain pan sloped to a drain connection for positive drainage;
  - .4 Condensate pump.

- .3 Factory run tested, weatherproof condensing unit equipped with a control board to interface with indoor unit and perform all necessary operation functions. Pre-charge unit with R-410a refrigerant for a minimum of 21 m (70') of refrigerant tubing. Unit is to be capable of operation at -18°C (0°F) without additional low ambient controls, and capable of a height difference between condensing unit and evaporator of 30 m (100'). Each condensing unit complete with:
  - .1 galvanized steel plate cabinet with an electrostatically applied thermally fused polyester powder finish, and an ABS plastic fan grille;
  - .2 draw-through direct driven balanced fan with horizontal air discharge, mounted in front of coil, arranged to pull air across coil, and equipped with a raised fan guard;
  - .3 "L" shaped coil with copper tubes and aluminium fins, factory pressure tested, complete with an integral metal guard and refrigerant flow controlled by a linear expansion valve metering orifice controlled by a microprocessor controlled step motor;
  - .4 vibration isolated DC rotary compressor driven by an inverter circuit to dynamically control compressor speed to match room load, complete with an accumulator, high pressure safety switch, and circuitry to permit a minimal amount of current to be applied to motor to maintain enough heat during off cycle to prevent liquid from accumulating.
- .4 System controls consisting of a microprocessor in each indoor and outdoor unit, and an indoor wall mounted controller site connected to indoor evaporator unit. System is to be capable of automatic restart after power interruption, and have self-diagnostics ability and indication of total compressor run time, and following:
  - .1 Indoor unit microprocessor is capable of monitoring return air temperature and evaporator coil temperature, receiving and processing commands from wall mounted controller, providing emergency operation, and controlling outdoor unit through its microprocessor and interface board;
  - .2 controller is complete with an integral temperature sensor, able to perform input and output functions necessary to operate system, and equipped with following:
    - .1 large DOT liquid crystal display to indicate diagnostic codes for both indoor and outdoor units, compressor run time, a weekly timer with up to 8 pattern settings per day, set temperature, room temperature, refrigerant piping temperatures, compressor operating conditions, and linear expansion valve opening pulses, sub-cooling and discharge super heat;
    - .2 On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louvre Swing button, a Ventilation button, a Test Run button, and a Check Mode button.
- .5 Acceptable manufacturers are:
  - .1 Mitsubishi Electric Sales Canada Inc.;
  - .2 LG Electronics Canada Inc.;
  - .3 Panasonic Canada Inc.;

.4 Fujitsu General America Inc.;

.5 Daikin Industries Ltd.

### **3 EXECUTION**

#### **3.01 INSTALLATION OF SPLIT SYSTEM AIR CONDITIONING EQUIPMENT**

- .1 Provide split system air conditioning equipment consisting of an exterior condensing unit and an indoor evaporator.
- .2 Secure condensing unit in place, level and plumb, on vibration isolation pads on a concrete housekeeping pad.
- .3 Mount indoor evaporator unit. Confirm exact location prior to roughing-in.
- .4 Connect condensing unit and indoor evaporator with refrigerant piping in accordance with piping shop drawing schematic. Refer to Section entitled Refrigerant Piping, Valves, and Accessories. Provide any required additional refrigerant.
- .5 Install loose control components and perform required control wiring (except building automation system connections) between condensing unit and evaporator in conduit in accordance with manufacturer's control wiring schematic and wiring standards of electrical work.
- .6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .8 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

**END OF SECTION**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for motorized heaters, including accessories.
- .2 Submit a site start-up report from manufacturer's representative as specified in Part 3 of this Section.

**2 PRODUCTS**

**2.01 CABINET UNIT HEATERS**

- .1 CSA certified hot water cabinet unit heaters in accordance with drawing schedule, each complete with:
  - .1 cabinet, of welded fabrication, constructed from one-piece top and sides, and one-piece partition panels and backsheet, both die-formed from single sheets of minimum #18 gauge insulated furniture grade steel and complete with minimum 825 mm (32-1/2") space at each end for piping and wiring, stamped grilles where required, and, for surface floor and wall mounted cabinets, key lock access doors for access to valves and speed controls;
  - .2 #16 gauge removable front panel with tamperproof fasteners, stamped grille where required, and insulation applied to the inside face;
  - .3 for all exposed cabinet surfaces, a baked enamel prime coat finish applied to cleaned metal surfaces;
  - .4 factory leak tested heating coil, consisting of seamless copper tubing mechanically expanded into and permanently bonded to continuous plate type aluminum fins, and equipped with screwed steel supply and return piping connections and silver brazed tube joints;
  - .5 removable galvanized steel fan board with centrifugal forward curved, formed aluminum fan wheel(s) with galvanized steel housings, direct connected to a continuous duty, three-speed, permanent split capacitor motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods;
  - .6 permanent, cleanable aluminum mesh filter;
- .2 Acceptable manufacturers are:
  - .1 Modine Manufacturing Co.;
  - .2 Rosemex Inc.;
  - .3 Armstrong-Hunt Inc.;
  - .4 McQuay International;
  - .5 Engineered Air.

**3 EXECUTION**

**3.01 INSTALLATION OF MOTORIZED HEATERS**

- .1 Provide motorized heaters.
- .2 Carefully coordinate installation of cabinet heaters with trades constructing building surfaces in or on which heaters are located. Confirm exact locations prior to roughing-in.
- .3 Connect with piping in accordance with drawing detail.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .5 Include for a 4 hour on-site heater operation demonstration and training session. Training is to be a full review of all components including but not limited to construction details, operation, and maintenance.

**END OF SECTION**



## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 Submit shop drawings/product data sheets for following:
  - .1 all control system components;
  - .2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
  - .3 certified wiring diagrams for all systems.
- .2 Submit following samples for review:
  - .1 control damper section with linkage, operator, and certified flow and leakage data;
  - .2 wall mounting control system flow diagram as specified in Part 2 of this Section;
  - .3 each type of thermostat to be used, each identified as to intended use.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

### **1.02 QUALITY ASSURANCE**

- .1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- .2 Control system installation company is to have local parts and service availability on a 24/7 basis.
- .3 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

### **1.03 AUTOMATIC CONTROL VALVES AND OPERATORS**

- .1 Each control valve must be suitable in all respects for the application, including system pressure, and must have design output and flow rates with maximum pressure drops as follows:
  - .1 heating water valves for radiation units: \_\_\_ kPa (\_\_\_ psi);
- .2 Unless otherwise indicated, control valves for proportional operation are to have equal percentage characteristics, and control valves for open/shut 2-position operation are to have straight line flow characteristics. All valves are to have position indicators. Valves for outdoor applications must be suitable in all respects for the application.
- .3 Heating valves are to be normally open unless otherwise specified.

- .4 Cooling valves are to be normally closed unless otherwise specified.
- .5 Unless otherwise specified, control valves in hydronic piping systems are to conform to requirements specified in Section entitled HVAC Piping and Pumps.
- .6 Unless otherwise specified, valves in steam/condensate piping are to generally conform to requirements specified in Section entitled Steam and Condensate Piping and Pumps but must be equipped with stainless steel plugs and stems, removable screwed stainless steel seat rings, and spring loaded Teflon V-ring packing.
- .7 All control valve operators are to be spring return type for fail safe operation, sized to tightly shut the control valves against differentials imposed by system, equipped with position indicators, and suitable in all respects for environment in which they are located.
- .8 Electric valve operators are to be equal to Belimo "EF Series" enclosed reversible gear type operators that can accept modulating control signals as required. Each is to be 1-phase AC, 120 or 24 volt as required or indicated, overload protected, and complete with an enclosure to suit the mounting location.

#### **1.04 CONTROL DAMPERS AND OPERATORS**

- .1 T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4") deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be parallel blade type. Dampers for open-shut service are to be opposed blade type. Maximum blade length is to be 1 m (4'). Dampers greater than 2 sections wide are to be complete with a jackshaft. Each damper is to be complete with:
  - .1 extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;
  - .2 extruded TPE frame gaskets and extruded EPDM blade gaskets;
  - .3 slip-proof aluminium and corrosion resistant plated steel linkage of a metal thickness to prevent warping or bending during damper operation, concealed in frame, equipped with seal-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on hexagonal blade pin and rotating in a polycarbonate outer bearing inserted in frame.
- .2 For standard damper(s), Series 1000 as above.
- .3 For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.

- .4 Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit dampers to respond and go to required position in less than 15 seconds upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.
- .5 Electric damper operators are to be equal to Belimo EF Series 24 volt or 120 volt AC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.

#### 1.05 LOCAL CONTROL PANELS

- .1 NEMA 1 (NEMA 2 in sprinklered areas) wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, a perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.

#### 1.06 CONTROL SYSTEM COMPONENTS

- .1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.
- .2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:
  - .1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:
    - .1 room temperature, and duct temperature points,  $\pm 1^{\circ}\text{C}$  ( $\pm 0.5^{\circ}\text{F}$ );
    - .2 all other points,  $\pm 0.75^{\circ}\text{C}$  ( $\pm 1.3^{\circ}\text{F}$ ).
  - .2 room temperature sensors constructed for surface or recessed wall box mounting, complete with an adjustable set-point reset slide switch with a  $\pm 1.66^{\circ}\text{C}$  ( $\pm 3^{\circ}\text{F}$ ) range, individual heating/cooling set-point slide switches as required, a momentary override request pushbutton for activation of after-hours operation, an analogue thermometer;
  - .3 outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with a NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;

- .4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;
- .5 for ducts greater than 1.2 m (4') or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, an averaging string of sensors with capillary supports on the sides of duct/plenum;
- .6 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;
- .7 carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
  - .1 measurement range: 0 to 2000 ppm;
  - .2 accuracy: ±100 ppm;
  - .3 repeatability: ±20 ppm;
  - .4 drift: ±100 ppm per year;
  - .5 output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.
- .3 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:
  - .1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
    - .1 maintain accuracy up to 20 to 1 ratio turndown;
    - .2 reference accuracy: +0.2% of full scale.

- .2 medium to high differential water pressure, over 5 kPa (20" wc): equal to Setra or Mamac transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of  $\pm 1\%$  of full span (includes non-linearity, hysteresis, and repeatability);
- .3 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
  - .1 maintain accuracy up to 20 to 1 ratio turndown;
  - .2 reference accuracy: +0.2% of full span.
- .4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
  - .1 maintain accuracy up to 20 to 1 ratio turndown;
  - .2 reference accuracy: +0.2% of full span.
- .5 medium differential air pressure, over 1.5 kPa (5" wc): equal to Setra or Johnson Controls Inc. transmitters as specified above for low pressure air transmitters but performance requirements as follows:
  - .1 zero and span: (c/o F.S./Deg. F); .04% including linearity, hysteresis, and repeatability;
  - .2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F. S.;
  - .3 thermal effects:  $<+0.33$  F.S./ $^{\circ}$ F over 40 $^{\circ}$ F to 100 $^{\circ}$ F (calibrated at 70 $^{\circ}$ F).
- .4 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
  - .1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
    - .1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static tops on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as  $\pm 20^{\circ}$  in approaching air stream;
    - .2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors placed at equal distances along its length in accordance with ASHRAE Standards for duct traversing.

- .2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8"), and transmitter is to produce a 4 to 20 mA or 0 to 10 VDC signal linear to air velocity.
- .3 Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm (¾") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:
  - .1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16<sup>th</sup> Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
  - .2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;
  - .3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
  - .4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;
  - .5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.
- .4 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.
- .5 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.
- .6 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.
- .5 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
  - .1 equal to Veris Industries split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;
  - .2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of ±5%, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.

- .6 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.
- .7 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:
  - .1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;
  - .2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;
  - .3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;
  - .4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC and an appropriate scale range and pressure adjustment;
  - .5 water flow switches: equal to Johnson Controls Inc. Model P74;
  - .6 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 amperes at 120 VAC, a minimum 4.5 m (15') sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18") section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.
- .8 Control relays as follows:
  - .1 control pilot relays: equal to Johnson Controls Inc. or Lectro modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 amperes at 120 VAC;
  - .2 lighting control relays: latching type with integral status contacts rated for 20 amperes at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.
- .9 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an analog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.

- .10 Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:
  - .1 integral H-O-A switch to override controlled device pilot relay;
  - .2 status input to building automation system to indicate whenever switch is not in the Auto position;
  - .3 status LED to illuminate whenever output is On;
  - .4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.
- .11 Electronic/pneumatic transducers equal to Johnson Controls Inc. transducers with an output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.
- .12 Thermostats:
  - .1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, a cover and any required mounting and connection accessories.
  - .2 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.
  - .3 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
  - .4 Guards for thermostats are to be clear, ventilated polycarbonate covers with allen key locking hardware.
- .13 Humidistats:
  - .1 Direct or reverse acting (to suit system), proportional type, adjustable humidity controllers, each corrosion resistant, suitable in all respects for the application and complete with a nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, a cover, and required mounting and connection accessories.
  - .2 Duct mounting humidistats are to be complete with a display type cover, duct sampling chamber with 300 mm (12") long extruded pick-up tube for duct mounting, a moulded mounting base, and a ventilated cover.
- .14 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section entitled Building Automation System, points schedule, and drawing control diagrams and operation sequences. All such hardware is to be suitable in all respects for interface with the building automation system.

## **1.07 SYSTEM WIRING MATERIALS**

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

## **2 EXECUTION**



**2.01 DEMOLITION**

- .1 Perform required control system demolition work.
- .2 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

**2.02 GENERAL RE: INSTALLATION OF CONTROLS**

- .1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.
- .2 Control systems are to generally be as indicated on drawing control diagrams and are to have all the elements therein indicated or implied.
- .3 Control diagrams show only the principal components controlling the equipment and systems. Supplement each control system with all relays, transformers, sensors, etc., required to enable each system to perform as specified and to permit proper operation and supervision.

**2.03 INSTALLATION OF CONTROL AIR COMPRESSOR SET AND DRYER**

- .1 Provide a duplex air compressor set. Secure set in place on vibration isolation on a concrete housekeeping pad. Install flexible piping connections supplied with set and connect with required piping, including drain piping extended and terminated at nearest drain.
- .2 Wall mount power and control panel(s) adjacent to equipment. Connect compressor set panel pressure switch with copper tubing to compressor set.

**2.04 SUPPLY OF CONTROL AIR DAMPERS AND OPERATORS**

- .1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.
- .2 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.
- .3 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.
- .4 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

**2.05 SUPPLY OF AUTOMATIC CONTROL VALVES AND OPERATORS**

- .1 Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.
- .2 Provide an operator for each valve.

**2.06 SUPPLY OF ACTUATORS, CONTROLLERS, AND TRANSFORMERS FOR TERMINAL UNITS**

- .1 Supply required 24 volt actuators, controllers, and transformers for terminal units.
- .2 Deliver actuators and controllers to successful terminal unit manufacturer's factory.
- .3 Coordinate delivery of product with General Contractor and successful terminal unit manufacturer.

**2.07 INSTALLATION OF THERMOSTATS**

- .1 Unless otherwise noted, provide required thermostats.
- .2 Provide a ventilated clear polycarbonate cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.
- .3 Unless otherwise indicated, mount room thermostats in accordance with requirements of local governing authority and, where applicable, barrier-free requirements. Review exact location of thermostats with Consultant prior to roughing-in.
- .4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.
- .5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

**2.08 INSTALLATION OF CONTROL SYSTEM COMPONENTS**

- .1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.
- .2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

**2.09 CONTROL WIRING**

- .1 Perform required control wiring work for control systems except:
  - .1 power wiring connections to equipment and panels, except as noted below;
  - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
  - .3 starter interlock wiring.
- .2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

- .4 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

## **2.10 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS**

- .1 Refer to identification requirements specified in Section entitled Basic Mechanical Materials and Methods.
- .2 Identify equipment as follows:
  - .1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;
  - .2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

## **2.11 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING**

- .1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting and balancing work.
- .2 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .3 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- .5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

**END OF SECTION**