MECHANICAL SPECIFICATIONS

HDSB NELSON HIGH SCHOOL
RENOVATIONS

4181 NEW ST., BURLINGTON, ON L7L 1T3

Project #: 23178
Revision 00
June 11, 2024

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

Date	Revision	Description	Prep. By	Check By
June 11, 2024	1	ISSUED FOR PERMIT	VK/FH	GR/TM
May 13, 2024	0	ISSUED FOR BID	VK/FH	GR/TM

END OF SECTION

PROJECT NAME: HDSB Nelson High School
Air Conditioning and Ventilation Upgrade

RDZ PROJECT NUMBER: 23214

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 Bid Form.

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

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

RDZ Engineers Ltd.
Attention : Giovanni Rea
e-mail : Giovanni@rdzeng.ca

Supplementary Bid Form Signature:

…….

(Signature of Authorized Representative)

…….

(Print Name)

…….

(Title)

LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. 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 as sole discretion of Consultant.

We also acknowledge that failure to submit this list as specified or failure to submit within time defined may result in provision of base specified manufacturer's product, at discretion of Consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
20 05 20	Mechanical Vibration Control	
20 05 25	Mechanical Insulation	
20 05 55	Firestopping and Smoke Seal Systems	
23 30 00	Louvres	
23 30 00	Grilles & Diffusers	
23 30 00	Silencers	
23 36 00	VAV boxes	
23 70 00	Packaged Rooftop Unit	
23 70 00	Semi Custom Outdoor Air Handling Units	
23 82 19	Packaged Unit Ventilators (UV-1, UV-2, UV-4)	
23 82 19	Vertical Unit Ventilators (UV-3, UV-7, UV-8)	
23 82 19	Horizontal Unit Ventilators (UV-5, UV-6)	

END OF DOCUMENT

1 GENERAL

1.01 REFERENCES

.1 Architect's front end documents 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 front end documents, conditions of front end documents 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/or "Municipal authority" – means government departments, agencies, standards, rules 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 Electrical Contractor, unless otherwise noted.

.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 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in “General Conditions”, however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

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 EXAMINATION OF DOCUMENTS AND SITE

.1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.

.2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.

.3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.07 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 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.

.11 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium time work to meet these requirements.

.12 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.

.13 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.

.14 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.

.15 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.

1.08 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.

1.09 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.

1.10 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.

.3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with Consultant.

1.11 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 ¼"=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.

1.12 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 as per HDSB's standards in front end documents (Article 8.1).

.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 Labour Estimating Manual, less 25%;

.4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labour Units at difficult level, less 25%;

.5 costs for journeyperson 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 building mechanical systems are not to be used for temporary heating or cooling purposes during construction.

.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 $500.00 CDN plus HST, per drawing, up to first 5 drawings, and $100.00 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.

.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.

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.

.5 Provide 2 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to Consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as reviewed with Consultant and enhanced with bookmarks and internal document links.

1.29 COMMISSIONING

.1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor 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, as further described below.

.1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section entitled Testing, Adjusting and Balancing.

.2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.

.3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.

.4 Submit final commissioning data sheets, TAB reports as specified in Section entitled Testing, Adjusting and Balancing, project closeout documents, and other required submittals.

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 1st month of building operation;

.2 once during 3rd month of building operation;

.3 once between 4th and 10th month in a season opposite to 1st and 3rd 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

1.01 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.

1.02 SUBMITTALS

.1 Submit shop drawings/product data sheets for:

.1 pressure gauges and thermometers;

.2 electric motors (submit with equipment they are associated with).

.2 Submit weight loads for selected equipment (upon request).

.3 Submit copy of reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.

.4 As specified in Part 2 of this Section, submit a spare belt set, tagged and identified, for each belt driven piece of equipment.

.5 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

2 PRODUCTS

2.01 PIPE SLEEVES

.1 Galvanized Sheet Steel – Minimum #16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.

.2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.

.3 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.02 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 included as part of mechanical work.

2.03 WATERPROOFING SEAL MATERIALS

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

.2 Acceptable products are:

.1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;

.2 The Metraflex Co. "MetraSeal" type ES.

2.04 PIPE ESCUTCHEON PLATES

.1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.

2.05 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 Base support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment is to consist of a base elbow support with flange.

.5 Floor supports for vertical risers as follows:

.1 copper tubing riser clamp – MSS Type 8;

.2 heavy-duty steel riser clamp – MSS Type 8.

.6 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.

.7 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;

.8 Special hangers and supports for various applications as follows:

.1 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;

.2 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;

.3 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;

.4 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;

.5 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.

.9 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.

.10 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.

2.06 ACCESS DOORS

.1 Access doors to be provided under work of Division 08 by General Trades Contractor.

.2 Coordinate with Mechanical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services, where possible, be accessible from common access door. Coordinate work to ensure same common location access doors are not supplied by more than one Division.

.3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.

.4 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain fire separation integrity.

.5 Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to Consultant for review.

2.07 PRESSURE GAUGES AND THERMOMETERS

.1 Pressure gauges as follows:

.1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") 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 (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;

.9 suitable thermowell.

.4 Acceptable manufacturers are:

.1 H.O. Trerice Co.;

.2 Weiss Instruments;

.3 Ashcroft.

2.08 EQUIPMENT BELT DRIVES

.1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:

.1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;

.2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch (± 10% range) for motors under 10 HP, fixed pitch type with split tapered bushing and keyway for motors 10 HP and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;

.3 motor slide rail adjustment plates are to allow for centre line adjustment.

.2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.09 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OHSA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-½") diameter tachometer openings at each shaft location.

.2 For flexible couplings – removable "U" shaped galvanized steel guards to OHSA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.

.3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (¾") galvanized steel wire mesh with galvanized steel frames, all to OHSA Standards.

2.10 ELECTRIC MOTORS

.1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.

.2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.

.3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.

.4 Unless otherwise specified, 1-phase motors smaller than ½ HP are to be 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.

.5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.

.6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.

.7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.

.8 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.

.9 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.

.10 Acceptable manufacturers are:

.1 TECO-Westinghouse Motors (Canada) Inc.;

.2 Canadian General Electric;

.3 Baldor Electric Co.;

.4 U.S. Electrical Motors;

.5 Weg Electric Corp.;

.6 Marathon Electric;

.7 Toshiba Corp.;

.8 Leeson Canada.

2.11 MOTOR STARTERS AND ACCESSORIES

.1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.

.2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.

.3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.4 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

.5 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

.6 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.

.7 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:

.1 enclosures located in sprinklered areas – Type 2;

.2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;

.3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;

.4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;

.5 enclosures except as noted above – Type 1;

.6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.

.8 Acceptable manufacturers are:

.1 Rockwell Automation Inc. - Allen-Bradley;

.2 Eaton Corp. – Cutler-Hammer;

.3 Eaton Corp. – Moeller Electric;

.4 Siemens Canada;

.5 Schneider Electric.

2.12 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 (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") 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
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN
heating water drain	yellow	HTG. WTR. DRAIN
refrigerant suction	yellow	REFRIG. SUCTION
refrigerant liquid	yellow	REFRIG. LIQUID
refrigerant hot gas	yellow	REFRIG. HOT GAS

.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.

2.13 FLEXIBLE CONNECTORS

.1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application. Acceptable manufacturers are:

.1 Hyspan Precision Products Inc.;

.2 Senior Flexonics Ltd.;

.3 The Metraflex Co.

3 EXECUTION

3.01 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

.1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.

.2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.

.3 Install pipes and ducts parallel to building lines and to each other.

.4 Neatly group and arrange exposed work.

.5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.

.6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.

.7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.

.8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.

.9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.

.10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.

.11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.

.12 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.

.13 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.

.14 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m [40']) piping runs to permit removal of sections of piping.

.15 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.02 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.

3.03 INSTALLATION OF PIPE SLEEVES

.1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:

.1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;

.2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.

.2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in 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 floors equipped with waterproof membranes;

.4 in roof slab;

.5 in waterproof walls.

.3 Size sleeves, unless otherwise specified, to leave 12 mm (½") clearance around pipes, or where pipe is insulated, a 12 mm (½") clearance around pipe insulation.

.4 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.

.5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.

.6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface concerned so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.

.7 "Gang" type sleeving will not be permitted.

.8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.

3.04 INSTALLATION OF WATERPROOF MECHANICAL SEALS

.1 Provide watertight link type mechanical seals in exterior wall openings.

.2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.

.3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

3.05 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

.1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

.2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.

.3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.06 INSTALLATION OF PIPE ESCUTCHEON PLATES

.1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.

.2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.07 INSTALLATION OF FASTENING AND SECURING HARDWARE

.1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of 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 floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.

.4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.

.5 Do not attach fasteners to steel deck without written consent from Consultant.

3.08 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: And at intervals specified in Div. B, 7.3.4.5.

.1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;

.2 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')

Max. 2.5m

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

.3 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 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:

.1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;

.2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;

.3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;

.4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;

.5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.

.10 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.

.11 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.

.12 Do not support piping from steel deck without written consent from Consultant.

3.09 SUPPLY OF ACCESS DOORS

.1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on 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 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.

.4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with Consultant prior to ordering.

.5 Group piping and ductwork to ensure minimum number of access doors is required.

.6 Submit a sample of each proposed access door for review prior to ordering.

.7 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.10 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.

3.11 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

.1 Provide pressure gauges in following locations:

.1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;

.2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;

.3 in expansion tank(s);

.4 in piping at each side of a pressure reducing valve;

.5 wherever else shown and/or specified.

.2 Provide thermometers in following locations:

.1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;

.2 wherever else shown and/or specified.

.3 Conform to following installation requirements:

.1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;

.2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;

.3 locate, mount and adjust instruments so they are easily readable;

.4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

3.12 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 Provide OHSA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.

.2 Install belt guards to allow movement of motors for adjusting belt tension.

.3 Provide a means to permit lubrication and use of test instruments with guards in place.

.4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.

.5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.13 MECHANICAL WORK IDENTIFICATION

.1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:

.1 at every end of every piping or 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 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;

.6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.

.2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:

.1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;

.2 at maximum 6 m (20') 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 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements and requirements of Painting Section in Division 09. Identify piping at intervals as specified above.

.5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.

.6 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 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;

.4 frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;

.5 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;

.6 hand an identified CD of valve tag chart to Owner at same time O & M Manuals are submitted.

.7 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:

.1	HVAC piping valves and equipment:	yellow
.2	fire protection valves and equipment:	red
.3	plumbing valves and equipment:	green
.4	HVAC ductwork dampers and equipment:	blue
.5	control system hardware and equipment:	orange

3.14 PIPE LEAKAGE TESTING

.1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.

.2 Tests are to be witnessed by Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.

.3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.

.4 Gravity Drainage and Vent Piping

.1 Test piping in accordance with local governing building code.

.2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.

.5 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.

.6 Natural Gas Piping

.1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.

.2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.

.3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.

.7 Refrigerant Piping

.1 Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 18 of ASHRAE Handbook - Fundamentals.

.8 Following requirements apply to all testing:

.1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;

.2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;

.3 when testing is carried out below highest level of the particular system, increase test pressure by the hygrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;

.4 include for temporary piping connections required to properly complete tests;

.5 piping under test pressure is to have zero pressure drop for length of test period;

.6 make tight leaks found during tests while piping is under pressure, and if this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;

.7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;

.8 tests are be done in reasonably sized sections so as to minimize number of tests required;

.9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.15 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

.1 Motor starters for mechanical equipment, except for starters integral with packaged equipment and starters factory installed in equipment power and control panels, will be provided as part of the electrical work.

3.16 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

.1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:

.1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;

.2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;

.3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;

.4 provision of receptacles for plug-in equipment;

.5 provision of disconnect switches for motors in excess of 10 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;

.6 motor starter interlocking in excess of 24 volts;

.7 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;

.8 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;

.9 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.

.2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

3.17 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

.1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.

.2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.

.3 Prior to each shut-down or interruption, inform Owner and Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.

.4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.

.5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. (1-800-661-9983) or Rigid Tool Co. RIGID "SuperFreeze".

3.18 CUTTING, PATCHING AND CORE DRILLING

.1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant’s approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by Consultant.

.2 Criteria for cutting holes for additional services:

.1 cut holes through slabs only; no holes to be cut through beams;

.2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;

.3 keep at least 100 mm (4") clear from beam faces;

.4 space at least 3 hole diameters on centre;

.5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;

.6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;

.7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.

.3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.

.4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.

.5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.

.6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.

.7 Firestop and seal openings in fire rated construction in accordance with requirements of article entitled Firestopping and Smoke Seal Materials in this Section. Do not leave openings open overnight unless approved by Owner and Consultant.

3.19 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

.1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:

.1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;

.2 exterior walls above grade – pack 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;

.3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

3.20 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

.1 Perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.

.2 Perform flashing work in accordance with requirements of drawing details, and requirements specified in Division 07.

3.21 CLEANING MECHANICAL WORK

.1 Refer to cleaning requirements specified in Division 01.

.2 Clean mechanical work prior to application for Substantial Performance of the Work.

.3 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.22 CONNECTIONS TO OTHER EQUIPMENT

.1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.23 INSTALLATION OF FLEXIBLE CONNECTORS

.1 Provide flexible connectors in piping connections to seismically restrained equipment, and wherever else shown.

.2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.24 FAN NOISE LEVELS

.1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.25 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

.1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.26 EQUIPMENT AND SYSTEM START-UP

.1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:

.1 submit a copy of each equipment/system manufacturer's start-up report sheet to Consultant for review, and incorporate any comments made by Consultant;

.2 under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

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 ⅔ 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 (¾") nominal thickness, selected for 3.2 mm (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 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.

2.04 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 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;

.6 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").

.7 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.

.8 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.

.9 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.

.10 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 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.

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 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 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.

.4 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m^3 (1-½ lb/ft^3) 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.

2.04 DUCTWORK SYSTEM INSULATION MATERIALS

.1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m^3 (3 lb/ft^3) 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^3 (1½ lb/ft^3) 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 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.

2.05 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".

2.06 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 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.

.5 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.

.6 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.

.7 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.

.8 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.

.9 Screws – No. 10 stainless steel sheet metal screws.

2.07 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 mil (0.4mm) 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 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 manufactured expansion joints and flexible connections;

.4 acoustically lined ductwork and/or equipment;

.5 factory insulated flexible branch ductwork;

.6 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 existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.

.8 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.

.9 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.

.10 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.

.2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to pipe at each roller hanger or support location. Pack saddle voids with loose mineral wool insulation.

3.03 PIPE INSULATION REQUIREMENTS – MINERAL FIBRE

.1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:

.1 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;

.2 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;'

.3 hot water heating piping, supply and return, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;

.4 hot water heating piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;

.5 refrigerant suction piping (between compressor and evaporator coil) inside building – 25 mm (1") thick;

.6 refrigerant hot gas piping (between compressor and condenser) 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.

3.04 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.

3.05 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.

3.06 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 (1-½") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 20 mm (¾") 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.

3.07 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.

3.08 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.

END OF SECTION

1 GENERAL

1.01 APPLICATION

.1 This Section specifies requirements, criteria, methods and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

2 PRODUCTS

Not Used

3 EXECUTION

3.01 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

.1 Where indicated on drawings, disconnect and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.

.2 Scope and extent of demolition or revision work is only generally indicated on drawings. Estimate scope, extent and cost of work at site during bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at site during bidding period site visits will not be allowed.

.3 If any re-design is required due to discrepancies between mechanical drawings and site conditions, notify Consultant who will issue a Site Instruction. If, in the opinion of Consultant, discrepancies between mechanical drawings and actual site conditions are of a minor nature, required modifications are to be done at no additional cost.

.4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.

.5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

3.02 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

.1 Co-ordinate shut-down and interruption to existing mechanical systems with school. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.

.2 Upon award of contract, submit a list of anticipated shut-down times and their maximum duration.

.3 Prior to each shut-down or interruption, inform Owner in writing 5 business days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent.

.4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.

.5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. or Rigid Tool Co. RIGID "SuperFreeze".

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 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.

1.03 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.

1.04 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.

1.05 COMMISSIONING AGENT

.1 Retain services of a qualified Commissioning Agent.

1.06 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 ASHRAE Guideline 1.2, The Commissioning Process for Existing HVAC&R Systems;

.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.

1.07 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.

1.08 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 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".

.3 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.

.4 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.

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 1st month after issue of a Certificate of Total Performance of the Work.

.4 Stage 4: Successful completion of satisfactory equipment/system operation during 3rd 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 1st month of building operation;

.2 once during 3rd month of building operation;

.3 once between 4th and 10th month of building operation but during a season opposite to 1st or 3rd 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 3rd 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 1st month of building operation;

.2 once during 3rd month of building operation;

.3 once between 4th and 10th months in a season opposite to 1st and 3rd 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 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".

.2 TAB of air handling and exhaust 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 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 ±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 ±5% of design values, and make and record measurements which are within ±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°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°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 Submit a product data sheet and WHIMIS sheet for each firestopping and smoke seal product.

.2 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.

.3 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.

.8 Where work requires removal of existing firestopping materials and replacement of firestopping materials after cabling changes have been made, ensure that replacement material is same material and manufacturer of existing if any remains in place, or ensure that all existing material is removed before installation of replacement material.

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 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.

.2 Cast Iron

.1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.

.3 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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 DEMOLITION

.1 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

.1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:

.1 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;

.2 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;

.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 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 in the wall at each new urinal or bank of urinals in a washroom;

.6 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.

3.04 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.

3.05 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.

3.06 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 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 45º 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.

.3 Shut off valves serving natural gas emergency generators are to be provided with valve position indicator and contact to initiate trouble alarm condition at the generator control panel.

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 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.

3.02 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 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.

3.03 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.

3.04 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 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1 The following work which is related to the work of this Section is specified in other Sections of the Specification:

.1 supply of piping or equipment mounted temperature control components;
.2 domestic water piping connections to equipment;
.3 drainage piping connections to equipment drain pans;
.4 provision of site applied thermal insulation for piping and equipment;
.5 circulating system testing, adjusting and balancing.

1.02 SUBMITTALS

.1 Submit shop drawings for all products specified in this Section except piping and unions.

.2 Submit 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.

1.03 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.

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 CIRCUIT BALANCING VALVES

.1 Tour & Andersson Series 787 threaded and Series 788 flanged for precise flow measurement, balancing, and positive shut-off with no drip seat. Each valve to be wye pattern, globe style with self-sealing EPDM measurement points, EPDM seat, and wheel handles with locking tamper-proof setting.

.2 Circuit balancing valves shall be sized based on design water flow and manufacturer's performance data. Refer to the following circuit balancing valve schedule for sizes.

Size (in)	Nominal Flow			
	Min. (gpm)	Max. (gpm)	Min. (l/s)	Max. (l/s)
1/2	0.6	2.8	0.038	0.177
3/4	2.0	6.0	0.126	0.379
1	3.9	10.0	0.246	0.631
1-1/4	5.0	15.0	0.316	0.947
1-1/2	6.6	20.0	0.416	1.262
2	12.6	36.0	0.795	2.272
2-1/2	38.0	100.0	2.398	6.310
3	31.0	130.0	1.956	8.203
4	68.0	200.0	4.291	12.620
5	90.0	320.0	5.679	20.192
6	182.0	450.0	11.48	28.395

.3 Acceptable manufacturer is Tour & Anderson (TA Hydronics) only.

2.04 PRESSURE RELIEF VALVES

.1 Dresser Industries Canada Ltd., "CONSOLIDATED", ASME tested, rated and certified, cast iron, bronze fitted, 1725 kPa rated pressure relief valves, each capable of relieving the full output of the equipment it is associated with, and factory set at 105% (percent) times the system pressure at the point in the system where the pressure relief valve is installed.

.2 Acceptable manufacturers are Dresser Industries Canada Ltd., Watts Industries, Kunkle, Spirax Sarco Canada Ltd., Singer Valve Co. Ltd., and Lonergan.

2.05 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 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 Apollo Valve 143 Series;

.3 Watts Industries (Canada) Inc. #BF-03;

.4 Kitz Corp. 6112 Series;

.5 Toyo Valve Co. 918DESL/G2.

2.06 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 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.

2.07 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.

2.08 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.

2.09 DRAIN VALVES

.1 Minimum 2070 kPa (300 psi) WOG rated, 20 mm (¾") diameter straight pattern bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") 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.

2.10 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.

2.11 AIR VENTS

.1 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 Armstrong International Inc. A1 Series;

.4 Watts Industries (Canada) Inc. #77SCI;

.5 Mueller Steam Specialty Products Model 11M screwed or Model 758 flanged.

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 HEATING WATER PIPING INSTALLATION REQUIREMENTS

.1 Provide all required heating water piping.

.2 Pipe, unless otherwise noted, shall be mild black steel, Schedule 40 for pipe to 8” (200 mm) diameter, Schedule 30 for pipe 10” to 18” (250 mm to 450 mm) diameter, and Schedule 20 for pipe 20" to 24” (500 mm to 600 mm) diameter.

.3 Piping to and including 2” (50 mm) diameter shall be screwed. Piping 2-1/2” (65 mm) diameter and larger shall be welded.

.4 Slope horizontal mains to provide a minimum continuous up-grade of 1” (25 mm) in 20’ (6 m) to high points. Slope branch supply and return piping connections to equipment a minimum of 1” (25 mm) in 4’ (1.2 m).

.5 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 drawiTOngs. 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.

.6 Provide an air relief vent in the high points of closed loop piping systems if the piping is not adequately vented into equipment.

.7 Provide circuit balancing valves in piping generally where shown on the drawings but with exact locations in accordance with instructions of personnel doing system flow balancing work. Confirm locations prior to installation. Balancing valves shall be sized according to design flow Ensure that balancing valves are a minimum of 10 pipe diameters downstream of any pump or fitting and a minimum of 5 pipe diameters upstream of any fitting.

.8 Pipe the discharge of each liquid piping safety relief valve to drain unless otherwise shown or specified.

.9 Check and test the operation of each liquid piping safety relief valve. Replace defective

.10 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 work specified the Section 25 05 05. Refer to the drawing control diagrams.

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 Confirm relief valve settings.

3.04 INSTALLATION OF AUTOMATIC AIR VENTS

.1 Provide automatic air vent at the highest point of each heating water system; including glycol water heating system.

.2 Connect discharge pipe from the automatic air vent to the nearest floor drain in accordance with the local authorities Building Code.

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 FLUSHING AND CLEANING PIPING

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

3.07 TESTING, ADJUSTING AND BALANCING

.1 Testing, adjusting and balancing for liquid heat transfer systems shall be performed by a Balancing Contractor retained directly by the Board and is not included in the mechanical contracts.

.2 The Mechanical Contractor shall co-operate with the Balancing Contractor and provide whatever assistance the Balancing Contractor may require in order to complete the work.

.3 Prepare the systems for balancing as follows:
- .1 open all valves to the fully open position;
- .2 check expansion tanks to ensure that they are not air bound and that the systems are full, check all air vents to ensure that they are installed properly and are operating freely and that all air is removed from the circulating systems, check operation of pumps, and check all strainer baskets to ensure that they are clean;
- .3 set all temperature controls so that all heat transfer equipment is operating at full output;
- .4 check the operation of automatic valves and adjust as required.

.4 The Consultant will spot check at the site, the results of the testing and balancing agency's testing and balancing report. Attend the spot checks.

.5 A copy of the approved testing and balancing report will be forwarded to you by the Consultant. Include a copy of the report in each copy of operating and maintenance manuals.

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 Submit duct leakage test data prior to ductwork being covered from view.

.4 Include the following with fan & accessories shop drawing/product data sheet submission:

.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.

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.

.3 Round

.1 Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.

2.02 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".

2.03 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.

2.04 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.

2.05 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.

2.06 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 Duct Construction Standards Metal and Flexible.

2.07 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.

2.08 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.

2.09 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.

2.10 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.

2.11 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.

2.12 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.;

.6 Alumavent.

2.13 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);

.6 Alumavent.

2.14 COMBINATION FIRE/SMOKE DAMPERS

.1 Nailor Industries Series 1220, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator.

.2 For applications where supply or return ducts terminate at a grille, at your option, provide:

.1 Nailor Industries 1221-OW “out of wall” high performance combination fire/smoke damper, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator accessible through the front supply/return grille, intumescent thermal insulation on all sides of sleeve.

.2 Nailor Industries 1221G combination fire/smoke damper for grilles, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator accessible through the front supply/return grille, grille mounting flanges. Coordinate grille size and mounting with damper requirements.

.3 ULC 1-1/2 hour fire rated and ULC Class I leakage rated for smoke, and equipped with a 74°C (165°F) ULC classified fusible link that will cause damper to close and lock independent of actuator when duct temperature reaches maximum temperature of damper assembly.

.4 Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.

.5 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 MOTORIZED DAMPERS

.1 TAMCO Series 9000 BF low leakage/thermal break thermally insulated air foil damper capable of achieving a 6.7 cfm/sq. ft. (34 l/s/sq. m.) at – 40 °F (– 40 °C) leakage rate at 4” (1 kPa) differential pressure and bearing the AMCA certification seal for air leakage and complete with:

.1 0.080” (2.03 mm) thick 4” (100 mm) deep extruded aluminium insulated frame with extruded TPE thermoplastic seals on the sides of the frame. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts;

.2 extruded aluminium, broken frame damper blade internally insulated with non-CFC expanded polyurethane foam, with EPDM gasketed blade seals integrally secured to the damper blade;

.3 acetal copolymer (Celcon) and polycarbonate bearings with no metal-to-metal contact;

.4 out-of-airstream linkages and crank arms constructed of aluminium and corrosion resistant, zinc & nickel plated steel, complete with cup-point trunnion screws.

.2 Dampers shall be sized for "flanged" installation (damper blade area to be equal to duct or plenum cross section area).

.3 Acceptable damper manufacturer is TAMCO only.

2.16 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.

2.17 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 (¾") 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 LOUVRES

.1 Price Industries Inc. DE439 or DE635, 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, storm-proof louvres sized as indicated on drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, mounting and securing hardware to suit the application, and 12 mm (½") mesh aluminum birdscreen in an aluminum frame.

.2 Louvres are to be factory finished with a finish equal to PPG Industries "Duranar" fluoropolymer powder coating over primer with colour as selected from manufacturer's standard colour range.

.3 Acceptable manufacturers are:

.1 Price Industries Inc.;

.2 The Airolite Co. LLC;

.3 Construction Specialities;

.4 Nailor Industries Inc.;

.5 Greenheck Fan Corp.

2.21 LOUVRE BLANK-OFF PANELS

.1 Insulated, framed, sandwich construction panels consisting of 40 mm (1-½") thick rigid insulation (meeting NFPA 90A requirements) between minimum #20 gauge galvanized sheet steel with exterior face of panels finished to match finish of exterior wall louvres.

2.22 SILENCERS

.1 Vibro-Acoustics silencers per the drawing schedule and as specified hereinafter, each certified to latest ASTM E477 "Standard Method of Testing Duct Liner Materials and Prefabricated Silencers For Acoustical and Airflow Performance" completely prefabricated and as follows:

.1 Materials

.1 Rectangular type silencers shall be constructed with a 22 gauge (0.78 mm) galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel.

.2 Elbow silencers shall be constructed with an 18 gauge (1.24 mm) galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" (1200 mm) shall have at least two half splitters and one full splitter.

.2 Acoustic Media:

.1 Film lined MoldBlock MediaTM silencers shall be Vibro-Acoustics® MoldBlock MediaTM containing 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, "flash dried" to provide resistance to mold, mildew and fungi. Media shall comply with UL181 and NFPA 90A. MoldBlock MediaTM shall be packed with a minimum of 15% compression during silencer assembly. Media shall not cause or accelerate corrosion of aluminum or steel.

.3 Acoustic Media Protection

.1 Film lined silencers shall be as above with acoustic media completely wrapped with Tedlar film to prevent shedding, erosion and impregnation of glass fibre. The wrapped acoustic media shall be separated from the perforated metal by a factory installed ½" (12 mm) thick acoustically transparent spacer. The spacer shall be flame retardant and erosion resistant. A mesh, screen or corrugated liner will not be acceptable as a substitute for the specified spacer.

.4 HTL Casings

.1 Where indicated on the silencer schedule, silencers shall have a high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. Provide breakout noise calculations as part of the silencer shop drawing submissions for each air handling and fan system with HTL silencers. Breakout noise shall be based on the sound power levels of the specified equipment.

.2 Manufacturer shall certify on shop drawings that silencer performance is per ASTM E477. Shop drawings submitted without same, will be rejected.

.3 Acceptable manufacturers are Vibro-Acoustics, J.P. Environmental Products Inc., Vibron and EH Price.

2.23 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;

.7 Metalaire.

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 Variable air volume ductwork from supply fans to boxes is as above but rectangular duct take-offs are double side straight taper type with a take-off length equal to 0.5 times the branch duct width but minimum 150 mm (6") length, and double taper side is to have an included angle of minimum 60°.

.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 wherever else shown.

.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.

.2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

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 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.

.4 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. **In conformance with Div. B, 3.1.8.9. and NFPA 80-13.**

.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 COMBINATION FIRE/SMOKE DAMPERS

.1 Provide combination fire/smoke dampers. Install dampers with retaining angles on all 4 sides of each side of damper, and, where required, connect with ductwork, all in accordance with damper manufacturer's instructions and details, and Code requirements. **In conformance with Div. B, 3.1.8.9A. and NFPA 80-13, 19.2.**

.2 Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.14 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.

3.15 INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS

.1 Supply supports for roof mounted ductwork.

.2 Accurately mark location and spacing of roof support assemblies. At each plastic base location, carefully scrape away loose roof ballast (gravel) and all other debris and dirt. Prime existing membrane with a primer which is compatible with existing roofing components. Set bases in adhesive in accordance with manufacturer's installation instructions. Scrape loose ballast back around and on bases. Install framing, and install ductwork on the cross-members. Secure ductwork to cross-members with galvanized steel banding.

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 LOUVRES

.1 Provide louvres for wall openings.

.2 Install louvre assemblies and secure in place in accordance with manufacturer's instructions and details.

.3 Confirm exact louvre sizes and finish prior to ordering.

3.19 INSTALLATION OF LOUVRE BLANK-OFF PANELS

.1 Provide blank-off panels for inactive portions of exterior wall louvres.

.2 Secure panels in place with non-ferrous hardware so they cannot move or rattle, yet are easily removable.

.3 Confirm exact finish of panels prior to fabrication.

3.20 INSTALLATION OF ACOUSTIC LINING

.1 Provide acoustic lining to the extent shown and/or specified on the drawings.

.2 Install lining in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.21 INSTALLATION OF SILENCERS

.1 Provide silencers where shown and as scheduled on the drawings.

.2 Secure and support each silencer rigidly in place, independent of the ductwork or casings connected thereto.

.3 Where silencers penetrate partition walls, seal the joint between the perimeter of the silencer and the wall, on both sides of the wall, with proper acoustic caulking.

3.22 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.

3.23 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 heat and energy recovery ventilators, including accessories, and all required power and control wiring schematics.

.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.

.4 Supply a spare filter set for each ventilator and store at site where directed prior to Substantial Performance of the Work.

.5 Submit a signed extended warranty direct from manufacturer to Owner covering the energy recovery wheel from material and workmanship defects for an additional 4 years after Contract warranty expires.

1.02 QUALITY ASSURANCE

.1 Energy recovery ventilator manufacturers are to be current members of 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;

.6 AHRI Standard 1060, Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment;

.7 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers;

.8 UL 1812, Ducted Heat Recovery Ventilators;

.9 CSA or ETL certification for all electrical components.

2 PRODUCTS

2.01 ENERGY RECOVERY VENTILATORS

.1 The ERV unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, control circuit board and blowers with motors, filters, and insulated foam air guides. Each unit will have an automatic by-pass damper system for economic operation under certain conditions. The unit shall have factory installed control board with functions for local, remote, and optional control modes.

.2 Unit capacities and performances to be as specified in equipment schedule.

.3 CABINET:

.1 The cabinet shall be fabricated of galvanized steel, and covered with polyurethane foam insulation as necessary with steel mounting points securely attached.

.4 BLOWERS:

.1 The unit shall be furnished with two (2) direct drive centrifugal blowers running simultaneously supplying and extracting air at the same rate for balanced ventilation air flow.

.2 The blower motors shall be a directly connected to the blower wheels and have permanently lubricated bearings.

.3 The blowers and motors shall be mounted for quiet operation.

.5 HEAT EXCHANGER:

.1 The heat exchanger element shall be constructed of specially treated cellulous fiber membrane separated by corrugated layers to allow total heat (sensible and latent) energy recovery from the exhaust air to the supply air or from the supply air to the exhaust air as determined by design conditions.

.2 The element shall have protective filters installed at both the supply and exhaust sides with an access cover to allow easy maintenance.

.6 BYPASS DAMPER:

.1 The ERV shall have an automatic supply side by-pass damper to allow inbound ventilation air to by-pass the energy transfer core when outside weather conditions warrant.

.2 The mechanism for opening and closing the bypass damper shall be a 208V-230V synchronous electric motor through an actuator. The motor will drive a steel cable connected to an mechanical damper flap to allow fresh air to bypass the Lossnay® element.

.3 Supply and return air thermistor shall control the damper and may be interlocked with a Mitsubishi Electric PZ Series LCD remote controller.

.7 FILTER:

.1 The ERV shall be equipped with factory installed MERV14 air filters located at each intake face (both supply and exhaust sides) of the core to clean the air and prevent clogging.

.8 PRE-HEATER:

.1 A suitable pre-heater shall be supplied and installed to pre-heat and maintain the air entering the ERV to above 14°F.

.2 The pre-heater to be provided by same supplier as ERV.

.9 MOUNTING:

.1 Mounting of the ERV shall be as indicated in the plans and drawings. The ERV shall not require condensate pan or receptacle nor condensate drain or piping. Mounting may be horizontal or vertical and the unit may be inverted as required by ductwork connection.

.10 ELECTRICAL:

.1 The units will require a 208-230Volt, 1 Phase, 60Hz power supply.

.11 CONTROL:

.1 ERV Control board shall allow independent control by contact closure from third-party sensor-driven controllers, switches, or timers.

.2 Terminal strip ready complete with PAC-SA88 adaptor.

.12 ACCEPTABLE MANUFACTURERS

.1 Lossnay (Mitsubishi Electric);

.2 Renewaire;

.3 Greenheck Fan Corp.;

.4 Venmar CES Inc..

3 EXECUTION

3.01 INSTALLATION OF ENERGY RECOVERY VENTILATORS

.1 Provide energy recovery ventilators.

.2 For suspended units, provide galvanized steel mounting brackets with vibration isolators and suspend each unit, level, and plumb, by means of hanger rods. Provide supplementary support steel as required.

.3 Coordinate power wiring connection and provision of a disconnect switch for each ventilator in accordance with electrical work Specification where power wiring is specified.

.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 ½ day on-site energy recovery ventilator operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full energy recovery ventilator internal inspection, construction details, operation, maintenance, abnormal events, and setting up controls.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

.1 Submit shop drawings/product data sheets for air terminals. Include following:

.1 capacity and pressure drop;

.2 sound power data to verify conformance with specified sound power levels;

.3 leakage and dimensions;

.4 mounting details to suit locations shown, indicating methods and hardware to be used;

.5 control components and a control wiring schematic.

.2 Submit with shop drawings/product data, a test report in accordance with ANSI/AMCA 210 requirements and ISO 3741, published test data on DIN (Direct Internal Noise) made by an independent testing agency for 2.5 and 6 m/s (8.2 and 19.7 ft/min) branch velocity or inlet velocity, sound power levels with a minimum inlet pressure of 0.25 kPa (0.036 psi) in accordance with ISO 3741 for the 2nd through 7th octave bands, and confirmation pressure loss through a silencer will not exceed 60% of inlet velocity pressure maximum.

.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 Air terminals manufacturers are to be current members of Air-Conditioning, Heating and Refrigeration Institute (AHRI), and terminals are to be in accordance with requirements of following standards:

.1 ANSI/AHRI Standard 880, Performance Rating of Air Terminals;

.2 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;

.3 International Organization of Standardization (ISO) Standard 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Precision Methods for Reverberation Rooms.

.2 Acceptable manufacturers are:

.1 Price Industries Inc.;

.2 Titus;

.3 Nailor Industries Inc.;

.4 Krueger Division of Air System Components Inc.

2 PRODUCTS

2.01 VARIABLE AIR VOLUME (VAV) TERMINAL BOXES

.1 Single duct, controller type, pressure independent variable air volume boxes in accordance with drawing schedule, each individually field adjustable to minimum and maximum air volumes, and complete with:

.1 #22 gauge galvanized steel housing, sealed and gasketed, internally lined with 25 mm (1") thick glass fibre duct lining material with a neoprene coating meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and complete with:

.1 exposed cut edges of the liner material factory coated with NFPA 90A and CAN/ULC S102 approved sealant;

.2 50 mm (2") long, round inlet duct connection;

.3 rectangular discharge opening with slip and drive cleat duct connection facilities;

.4 protective galvanized steel shroud for controller and damper actuator.

.2 air valve damper, normally open, galvanized steel blade with peripheral gasket, pivoting in self-lubricating bearings and with air leakage past a closed damper of 2% or less of rated capacity at 750 Pa (3" wc) inlet static pressure;

.3 air flow sensor located at box inlet, complete with gauge taps, multiple pressure sensing ports, and an averaging chamber designed to accurately average the flow across the inlet of box with an accuracy of within 5% with a 90° sheet metal elbow located directly at inlet, and amplify the sensed air flow signal;

.4 controller/actuator supplied as part of controls work specified in Section entitled Automatic Control Systems, shipped to box manufacturer's plant by controls supplier, and factory installed, connected, tested, calibrated and set by box manufacturer;

.5 galvanized steel attenuators, lined as per box housings, each factory supplied loose and with a length in accordance with drawing schedule;

.2 Terminal box to be complete with attenuator or lined discharge duct in place. Maximum sound power levels in decibels and specific static pressure are scheduled on drawings for each size of box.

3 EXECUTION

3.01 INSTALLATION OF TERMINAL BOXES

.1 Provide ceiling mounted terminal boxes.

.2 Secure each box in place from structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.

.3 Coordinate provision of transformers, actuators and controllers with Controls Contractor.

.4 Connect each box with ductwork as indicated. Provide straight inlet duct same size as box inlet and of a length equal to a minimum of 4 duct diameters. Refer to drawing detail. Coordinate final box adjustments and settings with personnel doing system testing and balancing work.

.5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

.6 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, and setting and adjusting controls.

END OF SECTION

1. GENERAL

1.01 SUBMITTALS

.1 Submit shop drawings/product data sheets for all rooftop units. Include following:
- .1 certified fan performance curves;
- .2 certified sound power data;
- .3 computer generated psychrometric chart for each cooling coil;
- .4 hardware for section-to-section site connections;
- .5 dimensioned layouts, including dimensioned curb layouts as applicable;
- .6 product data for fan motors.

.2 Submit with delivery of each unit 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 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 Unit installation tradesmen are to be journeyman and licensed gas fitters.

1.03 WARRANTY

.1 The warranty period shall commence at the date of initial start up and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include parts only.

.2 Manufacturer shall furnish a factory trained service technician to perform the unit start-up assistance to the installing contractor with licensed gas personnel. Factory technician to provide copy of start-up log to owner and to demonstrate operation and maintenance to owner's representative.

2. PRODUCTS

2.01 PACKAGED ROOFTOP UNITS

.1 Trane packaged rooftop units in configuration and performances as indicated on drawings and drawing schedules. Unit shall be factory assembled, internally wired, fully charged with R-410A, and 100% run tested to check cooling operation, fan and blow rotation, and control sequence before leaving the factory. Unit to have field convertible airflow. Units shall include all specified components installed and tested at the factory. Field fabrication of units and their components will not be accepted.

.2 <u>UNIT CASING</u>

- .1 Cabinet: Galvanized steel with baked enamel finish.

.2 Unit casing shall be zinc coated, heavy gauge, steel. Casing panels are weather resistant pre-painted metal with galvanized substrate and meet ASTM B117, 672 hour salt spray test.

.3 Cabinet top cover shall be one piece construction or where seams exits, it shall be double-hemmed and gasket-sealed.

.4 Unit shall include a removable single side maintenance access panels. Lifting handles in maintenance access panels can be removed and reinstalled by removing fasteners while providing a water and air tight seal.

.5 Unit's base pan shall have a raised 1 1/8 inch high lip around the supply and return openings for water integrity.

.6 Exposed vertical panels and top covers in the indoor air section are insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material.

.7 Base pan shall have no penetrations within the perimeter of the curb other than the raised 1 inch high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.

.8 Base of the unit is insulated with 1/8 inch, foil-faced, closed-cell insulation.

.9 Provide openings either on side of unit or through the base for power, control, condensate, and gas connections.

.10 Unit base shall contain provisions for forklift and/or crane lifting on three sides of unit.

.3 AIR FILTERS

.1 MERV 13 filters.

.4 FANS AND MOTORS

.1 Supply fan shall be a direct drive plenum fan with backward-curved fan wheel with an external rotor direct drive variable speed motor.

.2 Supply fan speed adjustments can be made using the control user interface or mobile app.

.3 Provide Fan Fail indication. The indication will be registered at the on-board user interface, mobile service app., or building management system.

.4 Variable speed direct drive motors are premium efficiency.

.5 Motors are thermally protected.

.6 Outdoor fans shall be direct drive, statically and dynamically balanced, draw through in the vertical discharge position. Outdoor motors shall be 3 phase.

.7 Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

.5 GAS FIRED HEATING SECTION

.1 The heating section shall have a progressive tubular heat exchanger with corrosion-resistant aluminized steel tubes and burners as standard on all models.

.2 On initial call for heat, the combustion blower shall purge the heat exchanger for 20 seconds before ignition.

.3 Completely assembled and factory installed heating system shall be integral to unit, UL or CSA approved specifically for outdoor applications for use downstream from refrigerant cooling coils. Threaded connection with plug or cap provided.

.4 Heating section shall be factory run tested prior to shipment.

.5 Induced draft combustion blower shall be used to pull the combustion products through the firing tubes. System shall use direct spark ignition (DSI).

.6 After three unsuccessful ignition attempts, entire heating system shall be locked out until manually reset at the thermostat/zone sensor.

.7 Induced draft blower to pull the gas mixture through the burner tubes.

.8 Compact cabinet features a tubular heat exchanger in low, medium and high heat capacities. Corrosion-resistant aluminized steel tubes and burners are standard on all models.

.9 Limit controls: High temperature limit controls will shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow or loss of indoor airflow.

.10 Units shall be suitable for use with natural gas or propane (field-installed kit).

.11 Through the base gas piping- the units shall include a standard through the base gas provision. This option shall have all piping necessary including black steel, manual gas shut off valve, elbows, and union. The manual shutoff valve shall include a 1/8 NPT pressure tap.

.6 EVAPORATOR COIL

.1 Evaporators shall aluminium microchannel that provide optimal heat transfer performance due to flat, streamlined tubes with small ports, and metallurgical tube-to-fin bond.

.2 Provide a removable, reversible, cleanable double sloped drain pan for base of evaporator coil constructed of PVC.

.3 Unit shall include a condensate overflow switch to shut the unit down in the event that a clogged condensate drain line prevents proper condensate removal from the unit.

.7 CONDENSER SECTION

.1 Provide vertical discharge, direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated, with integral thermal overload protection in a weather tight casing.

.2 Condensers shall be microchannel.

.3 Provide tool-less factory installed corrosion resistant louvered hail/vandalism guards to protect condenser coils from hail or physical damage.

.8 REFRIGERATION SYSTEM

.1 All units have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Suction gas-cooled motor with voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads standard with scroll compressors. Crankcase heaters are standard on all compressors.

.2 Compressors shall have thermostatic temperature motor winding control for protection against excessive temperatures caused by over/under voltage operation or loss of charge. Also provide high and low pressure switches.

.3 Thermal Expansion valves are standard for all models.

.4 All units have dual compressors.

.5 Units shall have cooling capabilities down to 0 degree F as standard. For field-installed low ambient accessory, the manufacturer shall provide a factory-authorized service technician that will assure proper installation and operation.

.6 Three stages of cooling available on 6 to 17.5 tons units and four stages of cooling available on 20 and 25 ton units.

.9 OUTDOOR AIR SECTION

.1 Units shall be available with barometric relief.

.2 Barometric relief shall provide a pressure operated damper that shall be gravity closing.

.3 Barometric relief shall prohibit entrance of outside air during the equipment “off” cycle.

.4 Provide spring return motor for outside air damper closure during unit shut down or power interruption.

.5 Provide microprocessor unit-mounted control which when used with an electronic zone sensor provides proportional integral room control. This UCM shall perform all unit functions by making all heating, cooling and ventilating decisions through resident software logic.

.6 Provide factory-installed indoor evaporator defrost control to prevent compressor slugging by interrupting compressor operation.

.7 Provide an anti-cycle timing and minimum on/off between stages timing in the microprocessor.

.10 SYSTEM CONTROL

.1 True / Multi-Zone VAV;

.2 Terminal Strip Ready.

.11 ROOF CURB

.1 Contractor shall provide factory supplied roof curb, 16 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.

.2 Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

.12 ACCEPTABLE MANUFACTURERS

.1 Trane;

.2 Daikin;

.3 Johnson Controls;

.4 AAON.

2.02 SEMI CUSTOM AIR HANDLING UNITS

.1 Engineered Air outdoor air handling units in configuration and performances as indicated on drawings and drawing schedules. Unit shall be factory assembled, internally wired, consist of filter sections, supply air fan section, high efficiency indirect gas heating section, DX cooling section, condensing section, motorized dampers, control panel, temperature sensors, and all other components required for a complete packaged installation.

.2 UNIT CASING

.1 Unit casing shall be of minimum 18 gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 Casings shall be supported on 150mm (6") minimum structural steel channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

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

.5 Units mounted on roof curbs shall incorporate a welded floor-to-base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked and tarred.

.6 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 18 inches (457 mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof mounting curb shall be provided by the Roofing Subcontractor.

.3 ACCESS DOORS

.1 Provide hinged access doors. Doors shall be fully lined with closed cell, automotive bulb gasket and lever lock roller type or Ventlock handles, operable from both sides. Removal of screwed wall panels will not be acceptable.

.2 Hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. In sections that doors open inward, provide a door handle on the interior of the unit as well.

.4 INSULATION

.1 All units shall be internally insulated with 2" thick 1 ½ lb/ft3 density, neoprene coated fibre glass thermal insulation, secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.5 FILTERS

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters.

.2 2" (50 mm) Extended Media (Pleated) Disposable Filters: Filters shall be extended surface pleated complete with 100% synthetic media that does not support microbial growth. Frame shall be a high wet strength beverage board with a cross member design that increases filter rigidity and prevent breaching. Frame shall be recyclable. Filters shall have an expanded metal support grid bonded to the air-exiting side of the filter to maintain pleat uniformity and prevent fluttering. Metal support grid shall be recyclable. The filters shall be MERV 8 per ASHRAE 52.2. and rated U.L. 900 Class II. A permanent re-usable metal enclosing frame shall be provided for side loaded applications.

.3 Final filters shall be 4” (102mm) MERV 13 and follow the standards as per above.

.6 FAN SECTIONS

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Air foil fans shall be equipped with greaseable, self aligning ball type pillow block bearings. The ratio of blast area to nominal outlet area for double width fans shall be 75% or greater.

.3 Drives shall be adjustable on fans with motors 5 HP (3.73 kw) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

.4 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.5 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 1" (25mm) static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a heavy glass fabric, neoprene impregnated, with a double locking fabric to metal connection.

.6 Fan motors shall be rated for fan duty, open drip proof, high efficiency (equal to CSA 390 M 1985) T-frame, and 575 Volt, 3 Phase, 60 Cycle

.7 COOLING SECTION

.1 Unit MUST conform to regulations set out in the Canadian Energy Efficiency Act for large air conditioners (condensing units). Packaged units shall be tested to CSA Standard C746-98 and must bear an EEV (energy efficiency verification) label provided by CSA.

.2 Where specified as factory packaged air conditioning unit, factory assembled split systems do not conform to the Canadian Energy Efficiency Act and will not be considered.

.3 Coils shall be constructed of copper tube, aluminium fin, copper headers with sweat connections.

.4 Fins constructed of aluminum shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.5 Refrigerant evaporator type coil shall be equipped with minimum 3 distributors connected to the coil by copper tubes. Provide a hot gas bypass valve on lead circuit. Solenoid valves, expansion valves, and related accessories are to be installed in the factory by the unit manufacturer.

.6 Refrigerant coil shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Maximum face velocity for the DX cooling coil shall not exceed 500 FPM. Coils exceeding the specified face velocity will not be accepted. Coils shall be CSA certified.

.7 Provide a minimum of 3 hermetic type compressors, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

.8 Packaged units shall operate down to 50° F (10° C) as standard. Multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with liquid line filter-driers, combination sight glass moisture indicators and service ports fitted with Schraeder fittings. Units with 9, 10 and 12 Ton hermetic compressors shall also incorporate load compensated thermal expansion valves with external equalizers. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

.9 Controls for hermetic compressor units shall include compressor contacts, supply fan contacts and overload protection control circuit transformer, cooling relays, ambient compressor lockout, high pressure controls and automatic reset low pressure controls.

.1 Provide five-minute anti-cycle timers.
.2 Provide inter stage time delay timers.

.8 INDIRECT GAS FIRED AUXILIARY HEAT

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

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

.3 Gas fired units shall be approved for operation in -40°F locations.

.4 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1" (25mm) of insulation between the outer cabinet and inner liner.

.5 Blower assemblies close coupled to duct furnace type heat exchanger are not acceptable.

.6 Units with optional high efficiency heat exchanger shall be tested and certified to ANSI standards to provide a minimum of 91% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

.7 The burner assembly shall be a blow through positive pressure type with an intermittent pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay c/w flame rod. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.

.8 Unit discharge air control shall include 15:1 turndown (HT burner). The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on-off cycling. Manufacturer shall provide a factory test proving indirect gas fired burner capable of 15:1 turndown ratio while maintaining minimum 91% efficiency throughout the range.

.9 Installation and venting provisions must be in accordance with C.G.A. Standard B149.1, ANSI Z223.1-NFPA54, and local authorities having jurisdiction.

.10 The condensate line from the unit must be piped directly under unit, through the roof curb. A neutralizer tank shall be provided by the manufacturer, to be connected by the contractor to the condensate line in an indoor space.

.9 CONTROLS PANEL

.1 Air handling units shall be factory wired and tested, and shall be certified by ETL, with C.S.A. approved components.

.2 Wiring shall be in accordance with the Canadian Electrical Code, Part 1, and pertinent sections of Part 2 of the Code pertaining to specific equipment type and purpose.

.3 All electrical circuits shall undergo a dielectric strength test (CSA C22.2-0) and shall be factory tested and checked as to proper function.

.4 Pre-wired air handling units shall bear an approved bilingual label with all the necessary identification marks, electrical data, and any cautions as required by the Canadian Electrical Code, Part 2.

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

.6 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet the C.S.A. standard of the specific installation.

.7 A non-fused disconnect shall be factory mounted on the surface of the unit.

.10 HRW TOTAL ENERGY WHEEL

.1 Provide an ARI certified (sizes AEW10-1200 to AEW10-3500) Recovery Air total energy wheel as manufactured and supplied by Engineered Air. The performance of the total energy wheel shall be certified to the ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program in accordance with ARI Standard 1060-2001. The effectiveness shall be reflective of the component performance only without the benefit of packaged equipment. Wheel material will not exceed a flame spread rating of 0 and a smoke developed rating of 40 when tested in accordance with UL 723 (2018) ASTM E84.

.2 The total energy wheel shall be constructed of sheet aluminium with alternate layers corrugated and with adjacent layers glued to each other for stability. Two ply lubricated polyester/cotton thread c/w a tensile strength of 4.35 lbs (1.98 kg) with a type “Z” twist direction shall be glued to the sheet aluminium for additional strength. The sheet aluminium shall be tension wound onto a central hub. All aluminium surfaces shall be coated with a “zeolite” 4Å molecular sieve coating to provide water vapour transfer from one air stream to the other.

.3 Where latent heat transfer is not required, a Recovery Air sensible wheel shall be constructed of sheet aluminium with alternate layers corrugated and with adjacent layers glued to each other for stability. Two ply lubricated polyester/cotton thread c/w a tensile strength of 4.35 lbs (1.98 kg) with a type “Z” twist direction shall be glued to the sheet aluminium for additional strength. The sheet aluminium shall be tension wound onto a central hub.

.4 The wheel shall be cleanable by vacuuming without damage to the aluminium or desiccant. Alternate reclaim devices shall meet or exceed the performance noted in the schedules without exceeding the fan power requirements specified.

.5 Wheels shall be held securely together with metal spokes extending radially from the hub to the peripheral banding. Wheels of 1800 mm diameter and smaller are provided in one piece construction. Wheels of 2100 mm and 2400 mm diameter shall be constructed with four removable pieces, and 2700 mm to 3500 mm wheels shall be constructed with eight removable pieces.

.6 The wheel shall be supported by two pillow block bearings which in turn are supported by a steel support. The bearings shall be located to maximize the free area of the rotor as much as possible. The bearings shall be replaceable without removing the wheel from the air handling unit.

.7 Wheels shall be provided with non-contact adjustable labyrinth seals around the perimeter of the wheel and across the face at the division between the supply and exhaust sectors to eliminate drag, wear, and ensure longevity.

.8 The unit shall be provided with a purge system to allow a percentage of outdoor air through the exhaust air sector to reduce the exhaust air entering the supply air stream.

.9 The wheel shall be driven by a continuous V-belt around the outer perimeter of the wheel connected to an inverter driven, three phase, AC motor for variable speed applications. Access to the motor and the drive shall be from the face of the wheel.

.10 The CenCon c/w ER-XM module shall be complete with proportional and integral control and discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in the discharge air temperature.

.11 The controller shall provide temperature and frost control operation c/w accurate supply air temperature control and summer/winter operation.

.12 Energy recovery control function shall be incorporated into the control of the system discharge air setpoint. The controller shall utilize the heat recovery device to its full ability prior to enabling additional heating or cooling devices.

.13 Controller shall provide frost prevention. When the exhaust air temperature drops below the frost threshold, the controller setpoint shall be overridden to maintain a specific setpoint in the exhaust airstream. This setpoint is calculated based on the dewpoint of the return air to ensure maximum heat recovery is maintained while not allowing frost to accumulate on the heat recovery device.

.14 On-Off Control: (for applications where frost prevention is NOT necessary). Ambient controls are used to start/stop the Total Energy Wheel. When the ambient temperature is below the heating set-point or above the cooling set-point, the wheel runs at full speed; otherwise, the wheel stops rotating for ventilation mode.

.11 ROOF CURB

.1 Contractor shall provide factory supplied roof curb, 16 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.

.2 Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

.12 ACCEPTABLE MANUFACTURERS

.1 Engineered Air;

.2 Haakon;

.3 Ventrol.

3. EXECUTION

3.01 INSTALLATION OF PACKAGED ROOFTOP UNITS AND OUTDOOR AIR HANDLING UNITS

.1 Provide rooftop units on roof.

.2 Provide required rigging and hoisting/moving equipment required to move units 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 Carefully coordinate installation of each unit with other trades making connections to unit, in particular, control connections.

.6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

.7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification. Submit a copy of the letter prior to Substantial Performance.

.8 Include for a one half 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.

END OF SECTION

1. GENERAL

1.01 SUBMITTALS

.1 Submit product data for all screening. Include following:

.1 installation details and hardware for site installation and connections;

.2 dimensioned layouts;

.3 data to confirm wind loading and seismic force Code approvals.

.2 Submit screen manufacturer's standard chart of screen finish colours for colour selection by Consultant.

2. PRODUCTS

2.01 ARCHITECTURAL SCREENING

.1 Equal to Spinnaker Industries Inc. Louvred or Corrugated Sliding Panel style architectural screening shipped knocked-down as an assembly kit which, when assembled, is to mount directly to mechanical equipment with no on-site modifications or roofing work, designed and approved for Exposure "D" wind loading and seismic forces in accordance with Code requirements.

.2 Style of panel to be confirmed during the shop drawing stage.

.3 Each kit to include:

.1 minimum #18 gauge extruded aluminium track;

.2 minimum #16 gauge galvanized steel outriggers;

.3 minimum #22 gauge painted corrugated panels which will permit equipment service access when mounted;

.4 required mounting and connection hardware.

.4 Screening components factory finished with a baked powder polyester finish meeting ASTM B117 standards for 500 hour salt spray, ASTM D3363 standards for H-2H pencil hardness, and ASTM D3359 standards for adhesion, and colour in accordance with paint colour selected by Consultant.

3. EXECUTION

3.01 INSTALLATION OF ARCHITECTURAL SCREENING

.1 Provide architectural screening for mechanical equipment on roof.

.2 Submit to screening manufacturer a "Reviewed" or "Reviewed as Noted" shop drawing of each piece of equipment for which screening is required. Request paint finish colour chip from Consultant as soon as possible and forward to screening manufacturer.

.3 Assemble and install screening 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. Include motor data sheets and all required information.

.2 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 Units are to be CSA or ETL listed and labelled, factory assembled and tested, shipped to site in one-piece, and are to be in accordance with requirements of following Codes and Regulations:

.1 CAN/CSA-C22.2 No. 236, Heating and Cooling Equipment;

.2 UL/ANSI 1995, Heating and Cooling Equipment;

.3 AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment;

.4 AHRI 390 – Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps;

.5 ANSI S12.60 – Acoustical Performance Criteria, Design Requirements, And Guidelines For Schools;

.6 applicable Provincial Codes and Regulations.

2 PRODUCTS

2.01 PACKAGED VERTICAL UNIT VENTILATORS (UV-1, UV-2, UV-4)

.1 Single packaged vertical unit ventilator factory assembled and tested, equal to Systemair model Sophomore IQ Series with performance as indicated on drawing schedule.

.2 UNIT CABINET:

.1 16-gauge frame supports, all internal metal pans, and components;

.2 Seams: Sealed, requiring no caulking in field;

.3 Interior Design:

.1 Fresh air intake & condensing fan relief;

.1 Ensures wall penetrations will be above 35-inches (minimum) from the finished floor level.

.4 Outer Cabinet Doors & Sides:

.1 Two fully insulated, full-sized hinged panels: Held closed by two tamper-resistant cam locks on each panel;

.2 Front Doors: Allow access to all internal components;

.3 18-gauge steel cabinet and panels;

.4 Attached to the frame without visible screws, rivets, or fasteners;

.5 Cabinet Paint:

.1 Powder coat, baked, enamel-textured finish:

.2 Cabinet Color: Gray, unless otherwise indicated by Architect.

.6 Non-fibrous Insulation within a Single Wall:

.1 Thermally/acoustically insulated with a minimum of 1-inch (25-mm) of thick, fiber-free, low density, foam;

.2 High sound absorption;

.3 Low thermal conductivity;

.4 Excellent emission properties;

.5 Microbiological resistance;

.6 High fire resistance;

.7 Low VOC emission properties, must meet or exceed ISO 16000 Class A requirements;

.8 Tested to ISO 846:2019 (A/B/C);

.9 UL94 V0/HF-1 flame rating;

.10 CAN/ULC S102 flame rating;

.11 Flame Spread Index, UL 723: Not over 25; Tested to ASTM E84 and ASTM E662.

.12 Smoke Developed Index, UL 723: Not over 50; Tested to ASTM E84 and ASTM E162.

.13 Blowing agents:

.1 Low Global Warming Potential (GWP);

.2 Accepted within the regulations outlined in the EPA SNAP Rule 21 and 22 programs.

.3 AIR DISTRIBUTION:

.1 24-inches x 12-inches Duct Collar Supplied with Unit Ventilator;

.2 Recommended external ducting and ceiling diffusers External Static Pressure (ESP): 0.1-inch−0.5-inches;

.3 Return Grilles designed to reduce generated sound with matching colour, standard, punched, and supplied with unit.

.4 AIR FILTRATION, AIR TREATMENT, AND DAMPERS:

.1 Two (2) 2-inch MERV-13 pleated disposable filters to filter 100 percent of both recirculated and outside fresh air.

.5 HOT WATER HEATING COIL:

.1 Constructed of seamless drawn copper tubes mechanically expanded into die-formed fin collars of aluminum, tempered, corrugated fin stock to ensure the positive bond for optimal heat transfer, and the prevention of electrolytic action.

.2 Supplied with a manual air vent, and a drain plug.

.3 Sized to provide the required heating capacity as per the schedule.

.4 Supply and return connections stubbed out the top of the unit on the left side with 1-inch nominal tubing.

.5 Hot Water Freeze Protection:

.1 Discharge Air Sensor Factory-equipped with unit to prevent the hot water from freezing due to an abnormal drop in discharge air temperature.

.6 Water Control Valves and Piping Components:

.1 The manufacturer supplies and installs a “Two-Way Modulating” spring return control valve, an isolation valve, a positive shut-off manual circuit balancing valve, and a wye strainer.

.7 Accessories:

.1 Unions at coil connections;

.2 Drain tap;

.6 SINGLE PACKAGED AIR CONDITIONING:

.1 Refrigerant Components to be Factory-equipped with unit ventilator and requires no field fabrication or installation of coils, line-sets, or condensing units.

.2 Designed and charged with R410A.

.3 Factory-equipped with one direct expansion valve and matched with the compressor.

.4 Provides required cooling capacity and performances as indicated in drawing schedules.

.5 Direct Expansion (DX) Coil Factory-equipped with Unit Ventilator:

.1 Mounted in evaporator coil section;

.2 Connected to correctly sized condensing coil in the condenser coil section;

.3 Orientation: Provides optimal heat transfer;

.4 Constructed with seamless drawn copper tubes mechanically expanded into die-formed fin collars of aluminum, tempered, corrugated fin stock to ensure the positive bond for optimal heat transfer, and prevention of electrolytic action;

.5 Commercially clean and dehydrated;

.6 Endplates: Galvanized steel construction.

.7 STANDARD DRAIN PAN:

.1 Constructed of stainless steel metal;

.2 Front-to-back and side-to-side slope to the primary drain outlet to eliminate any standing water in the pan.

.8 COMPRESSOR FACTORY-EQUIPPED WITH UNIT VENTILATOR:

.1 Hermetically sealed, two-staged, scroll type compressor;

.2 Sized correctly to match the coils performance as indicated on drawing schedule;

.3 Mounted on rubber isolators to reduce vibration transmission;

.4 Internal Overload Protectors: Protects compressor from excessive motor temperature and current;

.5 High-Pressure Switch: Disables compressor from excessive system pressure;

.6 Low pressure cut out: Provided to disable compressor if refrigerant pressure is below an acceptable threshold;

.7 Compressor Crankcase Heater: Factory-equipped with each unit to prevent migration and mixing of refrigeration with the oil in the crankcase.

.8 Two-stage cooling sequence:

.1 First stage: 67 percent of compressor capacity.

.2 Second stage: 100 percent of compressor capacity.

.9 DAMPERS:

.1 <u>Ventilation Damper:</u>

.1 Insulated galvanized damper;

.2 Operated by zero maintenance and concealed linkage;

.3 Outside blade edge: Pressure-sensitive type for low leakage;

.4 Jamb seals: Pressure-sensitive type for low leakage;

.5 Dampers equipped with a Belimo spring return damper actuator with minimum torque of 18-inch-pound;

.6 Protected from overload at all angles of rotation

.7 Provides proportional damper control in response to input of 2−10 VDC

.8 Actuators: Equipped with a brushless DC motor controlled by a microprocessor:

.9 Modulates dampers to allow outside air to mix with return air:

.1 During occupied period, outside air fixed at 450 CFM.

.2 During economizer cycle, opens fully during economizer cycle to allow up to 100% of total supply air to enter through outside air damper.

.10 SUPPLY AND CONDENSING FANS:

.1 Supply Fan:

.1 Supply Motor and Fan Assembly: Consists of two-fan bodies to supply the specified airflow;

.2 Orientation: Allows mixed air to be drawn through both the heating and cooling coils;

.3 Fan body: Double-inlet centrifugal type blower;

.1 Both fans driven by one electronically commutated motor (ECM) capable of variable speed operation.

.4 EC Motor: Programmable to deliver the specified airflow at the rated ESP;

.1 Permanent Split Capacitor motors are not permitted.

.2 Provides efficient fan operation.

.3 Isolated from supply fans by zinc-plated double wire.

.4 Mounting brackets and rubber anti-vibration mounts: Dampens the noise induced by vibrations.

.5 Fan Assembly slider sits on felt insulation.

.2 Condensing Fan:

.1 Motor & Fan Assembly designed to cool condensing coil and to relieve stale room air at the same rate as outside air enters the space;

.2 Fans: Two backward curved centrifugal fans

.1 Driven by integral electronically commutated motors (ECM);

.2 Capable of variable speed operation;

.3 Permanent Split Capacitor motors are not permitted.

.3 Fan assembly capable of exhausting up to 100% airflow equal to incoming outdoor air.

.11 ELECTRICAL:

.1 Main Power Supply: Connects to unit through a wire raceway direct to either a terminal block or an unfused disconnect (provided by the manufacturer).

.2 Standard electrical supply voltage: 208 VAC 3 phase 60 Hz.

.3 Service Disconnect Supplied with Unit Ventilator:

.1 Line Voltage Service Disconnect: Maximum 80 amperes;

.2 Door Switch: Provides control voltage interrupt to disable mechanical components after removal of service panel;

.3 Disconnect Switch: Lockable in OFF position.

.4 All Internal Functions: Fuse-protected by a Time-delay Fuse rated properly for amperage load.

.12 CONTROLS:

.1 Terminal Strip Ready.

.2 Optional:

.1 Freezestat;

.2 Occupancy Sensor.

.13 ACCESSORIES:

.1 Full IQ Sound Package;

.2 Piping Package with isolation valve, Y strainer, 2-way modulating control valve, manual balancing valve ad blowdown valve.

.14 ACCEPTABLE MANUFACTURERS ARE:

.1 Systemair;

.2 Engineered Air;

.3 Airedale.

2.02 VERTICAL AND HORIZONTAL UNIT VENTILATOR (UV-3, UV-5, UV-6, UV-7, UV-8)

.1 Vertical unit ventilator factory assembled and tested, equal to Temspec model VUD with performance as indicated on drawing schedule. Unit complete with hydronic heating coil and DX cooling coil with remote condensing unit.

.2 Horizontal unit ventilator factory assembled and tested, equal to Temspec model HCD with performance as indicated on drawing schedule. Unit complete with hydronic heating coil and DX cooling coil with remote condensing unit.

.3 HOT WATER COIL:

.1 The coil shall have ½" copper tube of minimum wall thickness 0.016" and shall have aluminum fins. The coil supply and return headers shall be copper pipe, stubbed out for sweat connection. The coil shall be factory pressure tested at not less than 350 p.s.i. A manual air vent shall be factory installed and ball valves fitted. The coil capacity shall be as shown in the schedule.

.4 DIRECT EXPANSION EVAPORATOR COIL:

.1 The coil shall have 3/8" copper tube and aluminum fins. The coil capacities shall be as shown in the schedule. A galvanized steel pitched drain pan shall be provided. The pan shall have a 'P' trap.

.5 CABINET:

.1 VUD 1600

.1 The unit cabinet shall be 14ga corrosion resistant steel, braced and reinforced for rigidity. The finish shall be textured powder coat, color as per the Architect's instruction. The cabinet shall be fully lined with 1" coated glass fiber insulation. The return air grille shall be heavy duty steel.

.2 VUD 2000

.1 The unit cabinet shall be 14ga corrosion resistant steel, braced and reinforced for rigidity. The finish shall be textured powder coat, color as per the Architect's instruction. The cabinet shall be fully lined with 1" coated glass fiber insulation. The return air grille shall be heavy duty steel.

.3 HCD 1200

.1 The unit shall have a horizontal configuration with supply air discharge into high level duct work. The unit cabinet shall be 18ga corrosion resistant steel, braced and reinforced for rigidity. The finish shall be textured powder coat, color as per the Architect's instruction. The cabinet shall be fully line with ½" coated glass fiber insulation.

.4 HCD 1600

.1 The unit shall have a horizontal configuration with supply air discharge into high level duct work. The unit cabinet shall be 14ga corrosion resistant steel, braced and reinforced for rigidity. The finish shall be textured powder coat, color as per the Architect's instruction. The cabinet shall be fully line with 1" coated glass fibre insulation.

.6 SUPPLY AIR FAN/MOTOR:

.1 The fan shall be a direct centrifugal type with a three speed PSC motor mounted on rubber isolation grommets. The motor voltage shall be 208V/1/60Hz.

.2 Dual fans provided for model VUD 2000.

.7 MIXING AIR DAMPERS:

.1 The outdoor and return air dampers shall have airfoil section aluminum extruded blades. The dampers shall have neoprene blade tip and jamb seals. Leakage shall not exceed 4 c.f.m. per sq. ft. at 3" W.G. differential pressure, as determined by a recognized testing laboratory.

.8 ACCESS PANELS:

.1 Provide hinged access panels incorporated in one side of the HCD units to allow full access to all internal components.

.9 FILTERS:

.1 The filters shall be of the manufacturer's standard disposable type.

.10 LINE VOLTAGE WIRING:

.1 All internal line voltage wiring shall be by the unit manufacturer. A suitably rated remote circuit breaker shall be provided and installed by the electrical contractor.

.11 DDC CONTROLS:

.1 Control items shall be furnished by the contractor for factory mounting and shall function as described in the Controls Specification.

.12 ACCESSORIES:

.1 Unit manufacturer shall provide a colour matched top plenum extension for model VUD units, size to suit the ceiling height. The plenum shall have an internal perforated elbow and shall be acoustically lined.

.2 Unit manufacturer shall provide a colour matched raised base, height as shown on the plans, for model VUD units.

.3 Rear Plenum: (for model VUD units)

.1 Constructed of heavy 18-gauge steel with 1-inch (25-mm) flange for unit mount and painted in textured powder coat, finished to match cabinet colour;

.2 Factory-insulated with 1-inch (25-mm) acoustic material and includes a full uninsulated back;

.3 Assemble with field mounting to the unit required;

.4 Depth: 14-inches

.4 Sound Package;

.5 Piping Package with isolation valve, Y strainer, 2-way modulating control valve, manual balancing valve ad blowdown valve.

.13 ACCEPTABLE MANUFACTURERS:

.1 Temspec;

.2 Engineered Air.

2.03 ROOF MOUNTED CONDENSING UNIT

.1 Engineered Air, CSA approved and UL listed, package type, weather-proof, roof mounting, air cooled condensing unit with scroll compressor meeting ASHRAE 90.1 efficiency levels, factory assembled on heavy-gauge galvanized steel base. The refrigerant shall be R410A. The unit shall be shipped with a holding charge of dry nitrogen.

.2 Model, capacity, performance and characteristics are as indicated on drawings and drawing schedules. The unit shall meet the performance detailed in the schedule. Construction and ratings shall be in accordance with latest AHRI Standard, ANSI/ASHRAE 15, CSA-B52 and ASME Code.

.3 UNIT CABINET

.1 The unit shall be assembled on a rugged steel base. Unit casing and all structural members and rails shall be fabricated of pre-painted steel designed to withstand a 1000-hour ASTM B117 salt spray test.

.2 The condensing section shall be open on the sides and bottom to allow airflow through the coils. Single circuited units under 20 tons shall be equipped with full-face louvers for added protection and safety.

.4 REFRIGERATION

.1 Compressors shall be heavy duty Copeland scroll type, refrigerant gas cooled. Compressors shall be complete with thermal overload protection, low and high pressure control safeties and a liquid line shut off valve.

.2 On dual circuited units, each compressor shall also include gauge ports, an oil sight glass, crank case heater, anti-slug protection, and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.

.3 Provide liquid and suction line service valves.

.4 Compressors shall be mounted on resilient rubber isolators to decrease noise transmission.

.5 Provide hot gas bypass on one refrigerant circuit.

.5 CONDENSER

.1 Condenser fans shall be direct drive, propeller type designed for low tip speed, vertical air discharge, and include service guards. Fan blades shall be constructed of steel and riveted to a steel centre hub. Condenser fan motor shall be direct drive, permanently lubricated “PSC” motors with inherent thermal overload.

.2 Condenser coils on single circuited system under 20 tons shall be constructed with 3/8" copper tubing mechanically bonded to aluminum fins for maximum heat transfer. Dual circuited systems over 15 tons shall feature condensers fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Each refrigerant circuit shall provide 15 degrees of liquid subcooling.

.3 Single circuited units shall be provided with standard head pressure controls which cycle the condenser fan motors to maintain condensing pressures for operation down to 0°F ambient.

.4 On dual circuited systems, one condenser fan shall be controlled to maintain positive head pressure and an ambient thermostat shall be supplied to prevent the refrigeration system from operating below 45ºF ambient.

.6 ELECTRICAL AND CONTROLS

.1 All wiring shall comply with UL requirements. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring.

.2 Power and starting components shall include: circuit breaker for each compressor; fusing for the control circuit; compressor starting contactors; unit power terminal block for field connection to a single power supply and control power transformer.

.3 Provide unit with terminal strip for connection to field installed controls. Provide 4 stages of cooling.

.4 Provide factory installed phase failure protection.

.5 Electrical power requirement of unit shall match base building power available at site. Unit shall not be provided with Transformers or other power conversion devices to convert voltage to suit equipment electrical requirement.

.6 Acceptable manufacturers are Engineered Air, Daikin, and Trane.

3 EXECUTION

3.01 INSTALLATION OF UNIT VENTILATORS

.1 Provide unit ventilators.

.2 Secure each horizontal unit ventilator in place from structure by means of galvanized steel hanger rods, and vibration isolation elements supplied with units. Provide additional structural steel for unit support installation as required.

.3 Unless otherwise shown or specified, secure each vertical fan coil unit in place on floor, complete with vibration isolation pads supplied with units.

.4 Provide shut-off valves and install a control valve in piping for each coil. Refer to drawing detail and piping schematic.

.5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.

.6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

.7 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.

3.02 INSTALLATION OF ROOF MOUNTED CONDENSING UNIT

.1 Provide a package type condensing unit on the roof where shown. Secure the assembly in place, level and plumb, on vibration isolation on the roof support system provided.

.2 Connect the condensing unit and the indoor evaporator with refrigerant piping in accordance with the piping shop drawing schematic.

.3 Provide all required refrigerant and oil.

.4 When system installation is complete, check all equipment connections, start-up the equipment, test operation, and make any required adjustments under direct supervision of a qualified member of the equipment supplier's personnel and, when equipment is ready for acceptance, forward to the Consultant a letter stating that the equipment has been checked, started, tested and is ready for acceptance.

.5 When the letter has been received, the Consultant will visit the site to witness performance and acceptance tests on the equipment. Arrange for the equipment supplier's personnel to be present during the tests. Pay all costs associated with the equipment supplier's personnel at the site.

END OF SECTION

PROJECT NAME: Halton District School Board
Nelson High School
Air Conditioning and Ventilation Upgrade

RDZ PROJECT NUMBER: 23178

Following Supplementary Controls 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 Bid Form.

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

Where instructions are not provided, submit Supplementary Controls Bid Form by time of Bid closing, via e-mail addressed to:

RDZ Engineers Ltd.
Attention: Giovanni Rea
e-mail: Giovanni@rdzeng.ca

Supplementary Bid Form Signature:

.....

(Signature of Authorized Representative)

.....

(Print Name)

.....

(Title)

LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. 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 as sole discretion of Consultant.

We also acknowledge that failure to submit this list as specified or failure to submit within time defined may result in provision of base specified manufacturer's product, at discretion of Consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
25 09 23	Motorized Dampers	
25 09 23	Motorized Damper Actuators	
25 09 23	Temperature Sensors	
25 09 23	Control Valves	
25 09 23	Control Valve Actuators	
25 09 23	Room Sensors	
25 09 23	Pressure Transmitters	
25 09 23	Outside Air Sensors	

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 The approved Building Automations System Contractor per 2.1, referred to herein as the Contractor, shall provide a Direct-Digital Control System as indicated on the project documents in accordance with the drawings and as described in these specifications.

.2 Where existing legacy controls exist, the Contractor shall be responsible for the removal and preservation of existing controls and accessories, and to engineer, permit, provide and install a fully functioning Building Automation System which meets the requirements detailed herein.

.3 Where an Owner or Owner's representative provided points / object and equipment list is not provided as part of the bid package, the Contractor shall be responsible to verify existing site conditions and/or review all available drawings so to ensure all existing and/or currently proposed equipment at the facility is identified in accordance with 1.3.2, and is made part of the complete Direct-Digital Control System.

.4 The work administered by this Section of the technical specifications shall include all engineering, programming, labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required for a complete and fully functional Controls Systems.

1.02 DESIGN INSTRUCTIONS

.1 Design shall meet the functional intent of an "open", and interoperable Building Automation System, comprised of a network of stand-alone digital controllers. Incorporating the Niagara 4 Framework®.

.2 The Building Automation System is to include, but not limited to, the monitoring and/or control of **ALL** of the following equipment instances at each specified site:

.1 Boilers
.2 Fluid Cooler
.3 Air handling units
.4 Make up air units
.5 HVAC Equipment
.6 Energy recovery units
.7 Heat-pumps
.8 Exhaust fans
.9 Variable Frequency Drives
.10 Pumps
.11 Motors
.12 Valves
.13 Unit Heaters
.14 Radiant Heaters
.15 Electric Duct Heaters
.16 Exterior Lighting
.17 Utility Consumption and Demand Metering

.3 The system shall be modular in nature and designed for future flexibility so to accommodate the addition of functionality, control points or expansion of facility.

.4 The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the B-BC shall have no effect on the field controllers, including those involved with global strategies.

.5 Coordinate the specifications and equipment schedules in related sections for manufacturer furnished DDC systems to ensure the minimal hardwired points and sequences can be met. OEM DDC Systems, that meet the minimum hardwired points are preferred and approved for use with the following equipment ONLY; boilers, main air handling equipment, heat pumps and, fluid cooler. The supplier of the equipment is responsible for the configuration, programming, start-up, and testing of that product to meet the sequence of operation and specifications. The supplier shall also provide any licensing, hardware, and software required for interface to the DDC system.

1.03 DEFINITIONS

.1 Definitions of terms used in this section may differ from those given in general and supplementary conditions and take precedence over them.

BAS	Building Automation System
B-BC	BACnet Building Controller
B-AAC	BACnet Advanced Application Controller
B-ASC	BACnet Application Specific Controller
BACnet / BACnet Standard	Building Automation and Controls Network - ANSI/ASHRAE Standard 135-2012
BACnet/IP	BACnet Annex J – describes how BACnet devices can make use of IP directly for communicating across IP-based terminals
BBMD	BACnet Broadcast Management Device, see BACnet Annex J
BIBB	BACnet Interoperability Building Blocks: A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task
BTL	BACnet Testing Laboratory: A recognized, independent third party laboratory certified to test product for compliance to BACnet standards. BTL Certified products are indicated by a registered seal affixed to the product.
B/I	Binary Input
B/O	Binary Output
COV	Change of Value
cUL	Underwriters Laboratory Canada
DDC	Direct Digital Control
D/I	Digital Input
D/O	Digital Output
Embedded Control	Some OEM's (Original Equipment Manufacturer) equipment have a factory installed controller. These controllers must follow these standards. Examples can be found in chillers, boilers, variable frequency drives, etc. Proprietary communication protocols will not be allowed.
Gateway	A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2004). Gateways are NOT to be included unless approved by the Owner.

GUI	Graphical User Interface
HVAC	Heating, Ventilation and Air-Conditioning
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input / Output
LAN	Local Area Network (an individual school or site)
MS/TP	Master Slave Token Passing: Data link protocol as defined by the BACnet Standard. Operates over a serial field bus network (RS485)
NEMA	National Electrical Manufacturers Association
PICS	Protocol Implementation Conformance Statement: All devices conforming to the BACnet protocol shall have a documented statement that identifies all portions of BACnet that are implemented in the device.
P.I.D.	Proportional Integral Derivative
Shall	indicate a requirement that, in the view of the Board, must be complied with
UPS	Uninterruptible Power Supply Unit
VFD	Variable Frequency Drive
VLAN	Virtual Local Area Network: Dedicated for Facilities Services equipment
WAN	Wide Area Network (board wide)

1.04 REFERENCE STANDARDS

.1 Where edition date is not specified, consider that references to the manufacturer's data, and published codes, standards and specifications are made to the latest edition or revision, approved by the issuing organization.

.2 Reference Standards and specifications are quoted to establish minimum standards. Work in which quality exceeds the specified minimum will be considered to conform.

.3 The requirements of the Contract Documents govern over the requirements of reference standards and specifications.

.4 Standards, specifications, associations and regulatory agencies are generally referred to throughout the Contract Documents by their abbreviated designations, as listed below:

.1 AMCA American Movement and Air Control Association
.2 ANSI American National Standards Institute
.3 ARI Air Conditioning and Refrigeration Institute
.4 ASME American Society of Mechanical Engineering
.5 ASTM American Society for Testing and Materials
.6 ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
.7 CGA Canadian Gas Association
.8 CGSB Canadian General Standards Board
.9 CSA Canadian Standards Association
.10 NFPA National Fire Protection Association
.11 SMACNA Sheet Metal and Air Conditioning Contractors' National Association
.12 ULC Underwriters' Laboratories of Canada

1.05 SYSTEM ARCHITECTURE AND DESCRIPTION

.1 The Building Automation System as detailed in this Section shall be based on a hierarchical architecture incorporating the Niagara 4 Framework® through Tier 1 and 2 inclusive. Systems not developed on the Niagara 4 Framework® platform are unacceptable.

.2 All Niagara 4 Framework® components shall have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification.

.3 All devices supplied under this specification, excluding sensors, shall be connected to the site LAN and shall communicate natively using the following BACnet/IP, BACnet MS/TP, Peer to Peer, or Ethernet (ISO 8802-3), as defined in the ANSI/ASHRAE Standard 135, latest or Peer-to-Peer using Niagara's Fox Protocol or SNMP.

.4 Program databases, data acquisition and all control sequence logic shall reside in the respective B-BC, B-AAC and B-ASC controller. Each device shall, to the greatest extent possible, perform its programmed sequence. Operation of each device shall not be dependent on a connection to a server or master controller.

.5 The B-BC and any B-AAC or B-ASC shall be capable of updating firmware without the replacement of any hardware, microprocessors or chips.

.6 Each school / site shall be furnished with a single B-BC, which is responsible for and capable of providing fully distributed control including user access control and all necessary site computations at the site, independent of or under the Enterprise Management System and it must be stand-alone, multi-tasking, multi-user with a real-time digital processor. All controlled objects, sequences and associated operational parameters shall be both operator definable and modifiable through the embedded User Interface.

.7 The B-BC shall provide a web-based graphical user interface for programming, monitoring, and control, independent of any Enterprise Management System, be accessible remotely from a central site(s) and locally. The web-enabled user interface shall operate on an industry standard web-browser without the requirement of additional plugins.

.8 Each Mechanical or Electrical System and/or major piece of mechanical or electrical equipment shall have 1 dedicated B-AAC controller with sufficient I/O capacity such that it shall be connected to ALL field devices and points associated with that system, space and/or piece of equipment. B-ASC use shall be limited to VAV box applications provided the full functional intent can be met within the singular device.

.9 Mechanical and Electrical Systems i.e., VFD's, fluid cooler, boilers, unitary equipment, etc. units that are equipped with manufacturers furnished controls shall be BTL certified. Gateways are not to be used unless prior written approval has been acquired. A single B-AAC can be used in combination with the manufacturer supplied controls, only where the manufacturer's controls are unable to meet the functional intent, it shall be implemented in accordance with Section 25 09 93.

.10 The use of multiple application controllers used to control a single piece of equipment is strictly prohibited, except those specifically noted in 1.6.9.

.11 The system shall include real time monitoring of the following utilities; electricity (main feed), natural gas (main), and water (main). Meters supplied under this division shall communicate BACnet Natively. For existing meters, utility owned, coordinate integration requirements with the respective utility provider.

.12 The B-BC shall be connected to the HDSB Facilities VLAN, , to be supplied by the School Board at the School Board's expense.

.13 Site workstations, otherwise referred to as Caretaker PC, will be provided by the School Board.

1.06 HARDWARE AND SOFTWARE LICENSING

.1 The School Board shall be named license holder of all controllers and components, software and firmware supplied under this specification. The School Board shall receive ownership of all project specific configuration documentation, data files, and application-level software developed for the site.

.2 The School Board shall have unrestricted access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the building automation system

.3 All software provided shall be full featured and not limited or trial version.

1.07 USER CONTROL OVER CONFIGURATION

.1 The intent of this specification is to provide a system which shall allow the Board to independently do its own modifications to all objects, operational parameters and sequences.

1.08 INTELLECTUAL PROPERTY AND PROPRIETARY MATERIAL

.1 The Board shall sign a software and hardware licensing agreement, upon review and agreement of terms and conditions, as a condition of contract. Such license will grant use of all programs and application software to the Board and its representatives, as defined by the agreement, and shall protect the manufacturer's rights to disclosure of intellectual property contained within such software.

1.09 SYSTEM PERFORMANCE

.1 The System shall conform to the following minimum:

.1 The system shall report values with minimum end-to-end accuracy listed in Table 1.

Table 1 - Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	1% of range
Ducted Air Temperature	1% of range
Outside Air Temperature	±1°C (±2°F)
Water Temperature	1% of range
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see note 2)
Carbon Dioxide (CO^2)	±50 ppm
Electrical (kW, kVA, kWh, A, V, pF)	±1% of reading (see note 3)

Note 1: 10% - 100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility-supplied meters

.2 Control Stability and Accuracy shall maintain measured variable at set-point within tolerances listed in Table 2.

Table 2 – Control Stability and Accuracy		
Controlled Variable	Control Accuracy	Range of Medium Accuracy
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1°C (±2°F)	
Duct Temperature	±1.5°C (±3°F)	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-5- in. w.g.) differential

1.10 WORK COVERED BY THE CONTRACT DOCUMENT

.1 The Scope of Work for the Building Automation Systems Contractor shall include, but is not limited to the following:

.1 Furnish and install all necessary controllers, control and/or ancillary devices, sensors, wiring, software, licenses, and programming to deliver a complete and functional building automation system, which meets the functional intent of the systems design.

.2 The naming and addressing of all objects and devices to be in accordance with the specifications.

.3 Configure the web-based user interface embedded in the B-BC in accordance with the specifications.

.4 Coordinate equipment specifications for related sections necessary to meet the functional intent including variable frequency drives, dampers, valves, actuators, and peripheral devices considered to have wet surfaces such as pressure taps, thermal wells, flow switches, flow meters, etc. Preference is given to these devices being furnished by the Original Equipment Manufacturer, where applicable.

.5 Review and coordinate with other related sections so to ensure all mechanical and electrical systems and components to be integrated have the necessary hardware and software to meet the points and sequences specified.

.6 Coordinate with the School Board, the setup and communication of the B-BC on the School Board's supplied VLAN, in accordance with the specifications.

.7 Coordinate with the School Board and the respective utility provider, the installation and setup of utility metering equipment or the integration of any existing meters, in accordance with the specifications.

.8 Identify and label all controllers and associated devices including but not limited to connected I/O points, address', network id, etc.

.9 Attain, where required, all necessary permits and inspections

.10 Commissioning of new BAS.

.11 Submit the required documentation as described herein, including, but not limited to submittals, project record, start-up, commissioning, testing, acceptance documentation and system warranty.

.12 Operator Training.

1.11 PRODUCTS FURNISHED BUT NOT INSTALLED BY THE BUILDING AUTOMATION CONTRACTOR

.1 Hydronic Piping:
- .1 Control Valves
- .2 Flow Switches
- .3 Temperature Sensor Wells and Sockets
- .4 Flow Meters.

.2 Ductwork Accessories:
- .1 Automatic Dampers
- .2 Air Flow Switches

1.12 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED BY THE BUILDING AUTOMATION CONTRACTOR

.1 Fire Alarm Systems

.2 Utility Monitoring Systems

.3 Variable Frequency Drives

.4 Boiler, Fluid Cooler, Heat Pumps Equipment and Controls (BACnet Points necessary to meet specifications for monitoring and history only)

.5 Packaged Equipment and Controls (BACnet Points necessary to meet specifications for monitoring and history only)

1.13 RESPONSIBILITY MATRIX BY DIVISION CONTRACTOR

Work / Item / System	Furnish	Install	Control Wiring	Power
Control System Communication Wiring	25 09 23	25 09 23	25 09 23	n/a
Controls Equipment, panels, enclosures, and accessories	25 09 23	25 09 23	25 09 23	26
Interface to OEM furnished controllers supplied under Division 23	23	23	25 09 23	26
DOAS, Air Handling, HVAC Manufacturer furnished space mounted control (i.e., thermostat)	n/a	n/a	n/a	n/a
Fluid Cooler Level, Make-up Water and Sump Heater Control Devices (local control only)	23	23	23	23
Starters, operator switches	23	26	25 09 23	26
Automatic Damper (not OEM installed)	25 09 23	23	23 09 23	n/a
Automatic Damper Actuators	25 09 23	25 09 23	25 09 23	n/a
Hydronic Valves	25 09 23	23	25 09 23	n/a
Hydronic Valve Actuators	25 09 23	25 09 23	25 09 23	n/a
Thermo-wells (including accessories considered “wet”)	25 09 23	23	n/a	n/a
Hydronic Flow Switches and	25 09 23	23	25 09 23	n/a

Transducers				
Variable Frequency Drives not OEM Furnished	23	26	25 09 23	26
Fire Alarm control monitoring relay	28	28	25 09 23	26
Power Distribution Monitoring System	Utility	Utility	25 09 23	26
Natural Gas Utility Monitoring System	Utility	26	25 09 23	n/a
Water Meter Monitoring System	Owner	25 09 23	25 09 23	n/a
Fume Hood Controls (to be local control only)	23	23	23	26

1.14 QUALITY ASSURANCE

.1 The Controls Contractor shall be responsible for inspection and quality assurance for all materials and workmanship provided.

.2 The Controls Contractor shall have an established working relationship with the proposed BAS manufacturer of not less than 3 years.

.3 The Controls Contractor shall have successfully completed all control system training and certification as required by the manufacturer.

1.15 PERMITS, INSPECTIONS AND TESTING

.1 Contractor will arrange for submission to the Electrical Safety Authority (ESA) for review of this project, and pay all associated fees. Provide Certificate(s) of Acceptance from ESA and other Authorities having jurisdiction upon completion of the Work.

.2 Where modification to mechanical or electrical equipment control wiring is necessary to meet the requirements of the specifications, the contractor is responsible for arranging any testing required by the Authority Having Jurisdiction to maintain the required certification and ensure the safe operation of the equipment modified.

1.16 PERFORMANCE VERIFICATION OF INSTALLED EQUIPMENT

.1 Installed equipment may be subject to performance verification as specified herein if required by Owner or Owner's Representative(s).

.2 When performance verification is requested, equipment shall be tested to determine compliance with specified performance requirements.

.3 If requested, Contractor shall arrange for services of independent testing agency.

.4 Maintain building comfort condition when equipment removed from service or testing purposes.

.5 Promptly provide School Board, or School Board's Representative(s) with test reports.

.6 Should test results reveal that originally installed equipment meets specified performance requirements, School Board will pay costs resulting from performance verification procedure.

.7 Should test results reveal equipment does not meet specified performance, equipment will be rejected and the following shall apply:

.1 Remove rejected equipment. Replace with equipment that meets requirements of Contract Documents, including specified performance requirements.

.2 Replacement equipment may be subject to performance verification as well; use same testing procedures as performed on originally installed equipment.

.3 Contractor shall pay costs resulting from performance verification procedure.

1.17 SUBMITTALS

.1 All submittals and documentation including complete BAS System Engineering Design Submittal & Drawings, Project Record Documents, Application Engineering Documents and Owner's & Maintenance Manuals shall be submitted electronically in the form of an Adobe Portable Document Format (.pdf). All Control Schematics, Wiring Diagrams, Riser Diagrams, &c. shall be formatted for A3 11" x 17". Floor Plans shall be submitted in CAD format (.dwg). All other documentation may be formatted for 8.5" x 11".

.2 Submit in writing and so delineated at the beginning of each submittal, known substitutions and deviations from requirements of Contract Documents.

.3 Complete BAS Engineering Design Submittal & Drawings shall be prepared in accordance with Section 1.20 using the following guidelines:

.1 Submittal documentation and drawings shall consistently use the same abbreviations, symbols, nomenclature and identifiers. Each control system element shall be assigned a unique identifier pursuant with the Contract Documents

Submit the following:

.2 A complete bill of materials of all equipment, controllers, devices, sensors, actuators, valves, etc., necessary to meet the requirements detailed herein is to be provided, indicating unique equipment identifier/tag, unique device/controller identifier/tag, manufacturer and model number.

.3 Riser diagram of Local Area Network (LAN) shall outline execution and details of all network cabling, BAS & Network Hardware including the following:

.1 All BAS/DDC Hardware with controller number, MAC Addresses where required, unique identifier/tag, location, equipment and service.

.2 All Network Hardware with unique identifier, location and service

.3 Network cabling configuration and execution specification

.4 Location of all cabling termination points and End of Line (EOL) terminators

.5 Location of all network interface jacks

.6 A separate riser diagram shall be provided for each network segment

.4 Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Include for every BAS component including but not limited to the following:

.1 Gateways or BBMD associated networking peripherals

.2 Control Valves

.3 Dampers

.4 Actuators

.5 Variable Frequency Drives

1.18 SUBSTANTIAL COMPLETION REQUIREMENTS

.1 Contractor shall provide checklist for completion before Substantial Completion Field Review. Provide written declaration that work is complete. The following items shall be complete before Substantial Completion Field Review:

.1 Mechanical and Electrical systems capable of operation with Building Automation System, in operation with alarms functional.

.2 Tests on systems and equipment completed and certificates of approval obtained from regulating Authorities.

.3 Fire stopping completed, if required.
.4 Valve tagging completed and equipment, ductwork and piping identified.
.5 Escutcheons installed.
.6 Extended warranty form mailed to manufacturer and copy provided to Owner.
.7 Ensure access doors suitable located and equipment accessible.
.8 Ensure electrical connections to mechanical equipment are complete and motor rotation correct.
.9 Equipment cleaned inside and out, lubricated and paint touched-up.
.10 Commissioning, Testing, Demonstration and Acceptance.
.11 Complete program back-up and system files provided and verified for functionality.

1.19 PROJECT RECORD

.1 Upon completion of installation and systems commissioning, submit record documents for review. “As-Built” Project Record Documents should include:
  .1 Project Record Application Engineering Drawings shall include all BAS System Engineering Design Submittal with Drawings updated to reflect actual field conditions, architecture and execution.
  .2 Electronic Operating & Maintenance (O&M) Manual including:
    .1 Operator’s Manual with Manufacturers’ complete operating instructions.
    .2 Documentation of all project specific Application and DDC programs.
    .3 All necessary system Administrator-Level passwords and/or required access credentials.
    .4 Information required for programming BAS.
    .5 Complete Final Point Schedule including all hardware and software data points and documentation of calibration and configuration values for all Inputs, Outputs, Variables and PID Loops at the conclusion of systems commissioning and functional testing.
    .6 Routine preventative maintenance procedures, corrective diagnostic troubleshooting procedures and calibration processes.
    .7 Final Bill of Material with all installed parts, manufacturers, manufacturers’ part numbers and ordering information.
  .3 Sequence of Operation shall be submitted for every piece of equipment being controlled by and/or associated with the BAS. No operational deviation from specified Sequences of Operation as outlined in Contract Documents shall be permitted without prior written approval. Sequences of Operation shall include and conform to the following:
    .1 Refer to equipment and control devices by their specific unique identifiers/tags pursuant with the Contract Documents and BAS Submittal package.
    .2 Clearly represent actual Application Programming methodology and functional control operation. Do not merely provide a copy of Contract Document specified Sequence of Control.
    .3 Include description of functional system operation under normal and failure conditions.
  .4 BAS Control Schematics and Wiring Diagrams shall be submitted for every piece of equipment being controlled by and/or associated with the BAS. BAS Control Schematics and Wiring Diagrams shall include and conform to the following:
    .1 Floor plan showing exact location, MAC addresses where required, including unique identifiers of all hardware supplied under this section.
    .2 Control Schematic flow diagram of each system (air, water, gas, & etc.) being controlled showing actual physical configuration and control device/sensor location of all fans, coils, dampers, valves, pumps, heat exchangers, control devices, & etc. including each hardware point type, controller and associated ancillary devices.

.3 Controller termination details showing every controller point termination.

.4 Wiring Diagrams of all packaged equipment, motor starters, relay wiring, equipment interlock, safety circuits, & etc. clearly indicating all interconnecting wiring and termination of all conductors and cables including labels of all cables and points.

.5 Control Enclosure details for every enclosure including panel identifier, location, physical lay-out, dimensions, instrumentation, labels, & etc. Also include detail wiring (I/O, network and power) and power source for each panel, transformer and controller.

2 PRODUCTS

2.01 APPROVED MANUFACTURERS

.1 The following controls hardware and software, in no particular order of preference, are approved for use:

Manufacturer	Tier 2 Product Line	Manufacturer Assigned Vendor
Alerton	AIE Niagara 4	HTS Engineering Ltd (115 Norfinch Drive, North York, ON)
Distech Controls	EC-BOS Niagara 4	Energy Controls & Mechanical Services Inc. (Kitchener)

2.02 SOLE VENDOR SITE DESIGNATION

.1 Any minor site additions or upgrades, requiring manufacturer specific products as detailed herein will be that of the Approved Manufacturer for the site, per 2.3.

.2 The Board reserves the right to change the status of an Approved Manufacturer at any time should they not meet the performance or requirements detailed herein.

2.03 BUILDING CONTROLLER (B-BC)

.1 The B-BC shall be BTL certified, communicate BACnet Natively and incorporate the Niagara 4 Framework®.

.2 The B-BC shall have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "*", it shall be understood to mean that parameter is open to all possible values. Note that this will result in the following entries in the license.dat file:

Specific Feature	license.dat file entry value
Owner	"HDSB"
Project	"HDSB"
BrandId	"*" preferred, "Distech" or "Alerton" acceptable
accept.station.in	"*"
accept.station.out	"*"
accept.wb.in	"*"
accept.wb.out	"*"
Expiration	
All expiration instances	"never"
Limit	
[1]All .limit instances	"none"
Export	
BACnet	"true"
obix	"true"
Import	
rdbSqlServer	"true"
web	
ui	"true"
ui.wb	"true"
ui.wb.admin	"true

[1] With the exception of limitations defined by hardware configuration

.3 The B-BC shall function in a real-time, multi-tasking networked operating environment. It must complete all necessary site computations based on information from any object in the internetwork and locally execute global strategies and supervisory control for all field devices supplied under this specification, without additional hardware or software and independent of or under a B-AWS. It shall be capable of executing application control programs to provide the following:

.1 Calendar Functions
.2 Scheduling
.3 Trending and Data Management
.4 Alarm Monitoring and Routing
.5 Real-Time Clock and Network Time Synchronization
.6 Network and User Management functions for all devices on the LAN

.4 The B-BC shall be equal to a JACE 8000 and be supplied with the following hardware features as a minimum:

.1 two (2) Ethernet ports
.2 two (2) RS-485 BACnet MS/TP port
.3 one (1) USB port
.4 Wi-Fi connectivity
.5 expansion capability
.6 a battery backup and/or non-volatile memory. If battery backup or non-volatile memory is not available an Uninterruptable Power Supply must be provided to maintain program file and data base for a minimum 24 hours.

.5 The B-BC shall contain sufficient memory to support its own operating system, User Interface, all specified control strategies and objects, energy management applications, data storage and trending, alarm annunciation, and network management.

.6 The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Google Chrome™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.

.7 The B-BC must enable access to the complete BAS system installed under this section, via web-browser. Access includes but is not limited to comprehensive programming capabilities for all controllers and real-time operational values via an embedded web-browser Graphical User Interface (GUI). The GUI shall support the latest version of standard web-browsers, without the requirement of additional plugins or software, and must be configured in accordance with these specifications.

.8 The B-BC shall provide alarm management to monitor, buffer, and direct alarms and messages to operator devices and memory files, to be assigned in accordance with these specifications. Each B-BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost.

.9 The B-BC shall have the ability to collect and archive any data, for any property of any object on the LAN, in accordance with these specifications. The embedded UI shall be capable of configuring the collection of data. The data shall be accessible in either the following formats, XML or CSV from the WAN Server Supervisory Software or through a standard web-browser.

.10 The B-BC shall be capable of maintaining an Audit log that tracks and archives all activities performed.

.11 The B-BC shall provide, a minimum of four (5) levels of local access privileges. The highest level, Administrator Level, shall allow the BAS administrator to perform application, database, and user management functions. Each login credentials shall be assigned to a pre-defined level of access.

.12 The B-BC shall provide WAN access privileges, including a comprehensive list of accessibility/functionality items, to be enabled or disabled for each user according to the level of access granted. Operators shall be able to perform only those commands available for the access level assigned to their login credentials. Login credentials are to be looked up using the Lightweight Directory Access (LDAP) through the BAS server.

2.04 ADVANCED APPLICATION CONTROLLERS (B-AAC)

.1 B-AAC's shall be BTL Certified.

.2 B-AAC objects, sequences and operational parameters must be configurable via the B-BC's embedded graphical user interface.

.3 Each B-AAC shall contain sufficient memory to support its own operating system, data storage and programming requirements.

.4 The B-AAC shall share and use data between all controllers on the network and shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have a real-time clock.

.6 The B-AAC shall continuously check the status of its processor and memory circuits and in the event an abnormal operation is detected, the controller shall initiate a predetermined failure mode and generate an alarm notification.

.7 Each B-AAC shall be supplied with a minimum 3 spare Universal I/O's.

2.05 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

.1 B-ASC use is limited to VAV box and will not be accepted for use in any other application.

.2 B-ASC's shall be BTL Certified.

.3 B-ASC objects, sequences and operational parameters must be configurable via the B-BC's embedded graphical user interface.

.4 Each B-ASC shall contain sufficient memory to support its own operating system, data storage and programming requirements.

.5 The B-ASC shall share and use data between all controllers on the network and shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.

.6 Controllers that perform scheduling shall have a real-time clock.

.7 The B-ASC shall continuously check the status of its processor and memory circuits and in the event an abnormal operation is detected, the controller shall initiate a predetermined failure mode and generate an alarm notification.

.8 Each B-ASC shall be supplied with a minimum 3 spare Universal I/O's.

2.06 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 condenser water valves: 5 psi;
.2 heating water valves: 2.5 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.

2.07 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 For stainless steel dampers, as above but constructed of type 316 stainless steel and equipped with Teflon blade bearings.

.5 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.

.6 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.

2.08 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;

.2 room sensors, associated with each “Room Controller” detailed in Section 25 09 93, are to be communicating type complete with integral override button, configurable set-point / offset adjustment and without a display. Only the following room sensors, associated with occupant comfort, are approved for use:

DisTech Controls - Allure EC-Smart-Comfort-SO
Alerton - Microtouch Wall Sensor

.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: per article 1.9 of this section;
.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.

.8 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 per article 1.9 of this section.

.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 ±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 per article 1.9 of this section.

.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 per article 1.9 of this section.

.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./°F over 40°F to 100°F (calibrated at 70°F).

.9 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 ±20° 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 places 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, 16th 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.

.6 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.

.7 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.

.8 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.

.10 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.

.11 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.

.12 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.

.13 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.

.14 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an anolog 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.

.15 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.

.16 Electronic 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.

.17 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 Line voltage thermostats are to be 115 volt.

.3 Low voltage thermostats are to be 24 volt electronic type.

.4 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.

.5 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.

.6 Guards for thermostats are to be clear, ventilated polycarbonate covers with allen key locking hardware.

.18 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 Electric humidistats are to be line voltage (115 volt), or 24 volt electronic type.

.3 Wall mounting humidistats are to be complete with a tamper-proof display type cover.

.4 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.

.5 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.

2.09 **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.

3. EXECUTION

3.01 INSTALLATION

.1 The BAS contractor is responsible to verify that equipment can be installed in accordance with the manufacturer's instructions and as detailed within these specifications, as such the contractor shall inspect the site and report any discrepancies, conflicts or omissions to the Owner or it's representative, for resolution prior to the commencement of work.

.2 Unless otherwise specified, meet manufacturer's latest printed instructions for materials, planned maintenance and installation methods.

3.02 OBJECT AND POINT NAMING

.1 Where the first four segments of the object / point name are configured by virtue of the Niagara Network Device Addressing, only the 5th segment shall be defined as the Object / Point Name herein and must be programmed in accordance with Schedule A of Section 23 09 93. It must be demonstrated, by way of the Niagara Enterprise Software instance, that the individual points are searchable by the School's Unique Identifier, or Controller/Equipment Identifier, or Point Name Abbreviation, or any combination of, across the Board's WAN, without interruptions and/or collisions.

.2 All BACnet objects and points programmed under these specifications, shall conform to the following case sensitive convention:

.1 First five characters = School's unique identifier

.2 Sixth character = Network number

.3 Seventh and eighth characters = Device number

.4 Ninth up to required not to exceed nineteen characters = Controller / Equipment Identifier

.5 Last segment = Point name abbreviation
Example: S1156_2_15_HP10_RmTemp (S1156 = Forest Trail, 2 = Network 2, 15 = 15th device on network, HP10 = heat-pump 10, RmTemp = Room Temperature)

.3 Object name segment shall be delimited by (_) character, however must be consistent by Vendor across all Board sites

.4 Where a BACnet object or point name is not explicitly detailed in Schedule A of these Specifications, the Owner shall supply the required information including, but not limited to, device name, instance number, point name, units, meta tag, etc.,

3.03 CONTROLLER AND DEVICE ADDRESSING

.1 Where the first four segments of the Controller and Device Addressing are configured by virtue of the Niagara Network Device Addressing, only the 4th segment shall be defined as the Object / Point Name herein and must be programmed in accordance with Schedule A of Section 23 09 93. It must be demonstrated, by way of the Niagara Enterprise Software instance, that the individual points are searchable by the School's Unique Identifier, or Controller/Equipment Identifier, or Point Name Abbreviation, or any combination of, across the Board's WAN, without interruptions and/or collisions.

.2 Each device or network installed and programmed under these specifications, shall be addressed and/or named as follows:

Device Instance
.1 First five characters = School's unique identifier
.2 Sixth character = Network number
.3 Seventh and Eighth character = Device number
.4 Ninth up to required not to exceed nineteen characters = Controller / Equipment Identifier
Example: S1156_2_15_HP10 (S1156 = Forest Trail, 2 = Network 2, 15 = 15th device on network, HP10)

BACnet Network Number
.1 First five characters = School's unique identifier
.2 Sixth character = Network number
.3 Seventh = Network and Type
Example: S1156_2_1 (S1156 = Forest Trail, 2 = Network 2, 1 = 1st MS/TP network)

MAC Addresses

0. B-BC

1. Maintenance Connection

2. Reserved

3. – 127. Master Range

128. – 254. Slave Range

255. Broadcast

.3 Object name segment shall be delimited by (_) character, however must be consistent by Vendor across all Board sites

3.04 CONTROLLER / DEVICE NAMING

.1 Each device or network installed and programmed under these specifications, shall be addressed and/or named as follows:

Device Instance
.1 First five characters = School's unique identifier
.2 Sixth character = Network number
.3 Seventh and Eighth character = Device number
.4 Ninth up to required not to exceed nineteen characters = Controller / Equipment Identifier
Example: S1156_2_15_HP10 (S1156 = Forest Trail, 2 = Network 2, 15 = 15th device on network, HP10)

BACnet Network Number
.1 First five characters = School's unique identifier
.2 Sixth character = Network number
.3 Seventh = Network and Type
Example: S1156_2_1 (S1156 = Forest Trail, 2 = Network 2, 1 = 1st MS/TP network)

MAC Addresses

4. B-BC

5. Maintenance Connection

6. Reserved

7. – 127. Master Range

129. – 254. Slave Range

256. Broadcast

2 Object name segment shall be delimited by (_) character, however must be consistent by Vendor across all Board sites

3.05 SCHOOL'S UNIQUE IDENTIFIER

.1 The School's Unique Identifier will be provided by Owner and must be used in the first segment, for all device, network, object, and point names.

3.06 CONTROLLER / EQUIPMENT IDENTIFIER

.1 The Controller / Equipment Identifiers are restricted to dedicated B-AAC and B-ASC controllers. Identifiers are limited those listed below. Where an identifier is not listed below the Owner shall supply the required information.
.1 AC# = Air Conditioning Unit
.2 AHU# = Air Handling Unit
.3 Blr# = Boiler
.4 BPB# = By-Pass Box (constant volume)
.5 Chiller# = Chiller
.6 CU# = Condensing Unit
.7 HVAC# = HVAC Unit
.8 HVAC#VAV# = HVAC Unit (associated with) Variable Air Volume Box
.9 HP# = Heat pump
.10 HWLoop# = Heating Water Loop
.11 HpLoop# = Heat-pump Loop
.12 HX# = Heat Exchanger
.13 MAU# = Make-up Air Unit
.14 Tower# = Cooling Tower
.15 UV# = Unit Ventilator
.16 VRF# = Variable Refrigerant Flow Condensing Unit
.17 VRF#AC# = Variable Refrigerant Flow Unit (associated with) Air Conditioning Unit
.18 VRF#AC# = Variable Refrigerant Flow Unit (associated with) Air Conditioning Unit

.2 Where a dedicated B-AAC or B-ASC is not configured specific to a system or unit, controller identifier is to be approved by Owner.

3.07 POINT NAME ABBREVIATION

.1 The Object / Point Name convention must be followed for the objects / points as listed in Schedule A of this Section, note abbreviations are case sensitive.

.2 Where an identifier is not listed below the Owner shall supply the required information.

3.08 PROGRAMMING

.1 Sequences of Operation are to be programmed in accordance with Section 25 09 93

.2 Programs for like equipment i.e, heat-pump, unit heater, etc. shall be consistent by controls vendor across the facility and all Board sites.

3.09 HISTORY AND TRENDING

.1 A minimum of 7 days history shall be maintained within the B-BC for the points identified in Schedule A of this Section.

.2 Data stored in the B-BC shall be uploaded to the B-AWS..

.3 Default Graphical trends, Navigation button per 3.9, shall be pre-configured.

3.10 SCHEDULING

.1 Scheduling feature shall include seven-day schedule, plus holiday or event schedule, each with start time and stop time. Schedules shall be individually editable for each day and holiday.

.2 The scheduling feature shall allow for each individual equipment to be assigned to one of the Schedule Groups which includes, but is not limited to:
.1 Administration
.2 Gymnasium
.3 First Floor Classrooms
.4 Second Floor Classrooms
.5 Kindergarten
.6 Library
.7 Daycare
.8 Theatre
.9 Cafeteria
.10 Refuge

.3 The Areas, associated schedule, and equipment grouping will be provided by Owner.

.4 Timed override feature shall allow a temporary change of the scheduled equipment. An override command shall be selectable by an individual unit, all units assigned to a given schedule group, or to all units in a building. Timed override shall terminate at the end of the event. Timed override feature shall be allowed by a password level.

3.11 DEMAND LIMITING

.1 Programming or schedules shall incorporate a delay such that there is a delay between the start-up of each Schedule Group.

.2 Equipment within the Schedule Group shall incorporate a delay such that there is a delay between the start-up of individual equipment within the Schedule Group.

3.12 ALARMS

.1 Logical and consistent alarm strategy must be used as defined within these specifications. The alarm strategy detailed herein applies to those objects identified in Schedule A of this section. It is expected that additional alarms be added when applicable, Owner to determine class.

.2 Alarms, not classified as Emergency or Communication / Network, shall have the following values adjustable: threshold, limit and time delay.

.3 Alarm actions, defined by Alarm Class, shall be annunciated as follows:
.1 Emergency (E): email, header button red, graphic with flashing alarm object, Alarm Portal B-BC record
.2 High Priority (H): graphic with flashing alarm object, header button red, Alarm Portal B-BC record
.3 General (G): Alarm Portal B-BC Record

.4 The complete object / point name shall be included in every alarm message, refer to "Object and Point Naming" within this specification section.

.5 The minimum shall be recorded by the B-BC for each alarm:
.1 Time and Date
.2 Complete object / point name
.3 Acknowledge time, date, and user who issued acknowledgement

3.13 USER ACCESS

.1 Set up the following 5 password levels to include the specified capabilities.

.1 Level 1: (The Board's BAS Administrator)

.1 Level 2 capabilities.
.2 All administrative rights
.3 View, add, change and delete user names, passwords, password levels.
.4 All unrestricted system capabilities including all network management functions.

.2 Level 2: (TBD)

.1 Level 3 capabilities.
.2 Configure system software.
.3 Modify control unit programs.
.4 Modify graphic software.
.5 Unrestricted except for viewing or modifying user names, passwords, password levels.

.3 Level 3: (Approved Facilities Staff and Board's HVAC Maintenance Technicians)

.1 Level 4 capabilities.
.2 Temporary override of designated objects and/or points.
.3 Temporary set-point value change.
.4 Change selected equipment schedules.

.4 Level 4: (Approved Facilities Staff)

.1 Level 5 capabilities.
.2 Acknowledge alarms.
.3 Change selected equipment schedules.

.5 Level 5: (Read Only)

.1 Display all graphic data.
.2 Trend point data.

.2 Level 1 and 5 will be accounts which reside locally within the B-BC.

.3 Level 2 through 4 will be will use LDAP for login credential authentication.

3.14 GRAPHICAL USER INTERFACE

.1 Provide a colour graphic home screen, floor plans, system flow diagrams for each system and summary screens, designed and sized for iPAD, with all points indicated on the points list in Schedule A of this Section, and in accordance with these specifications.

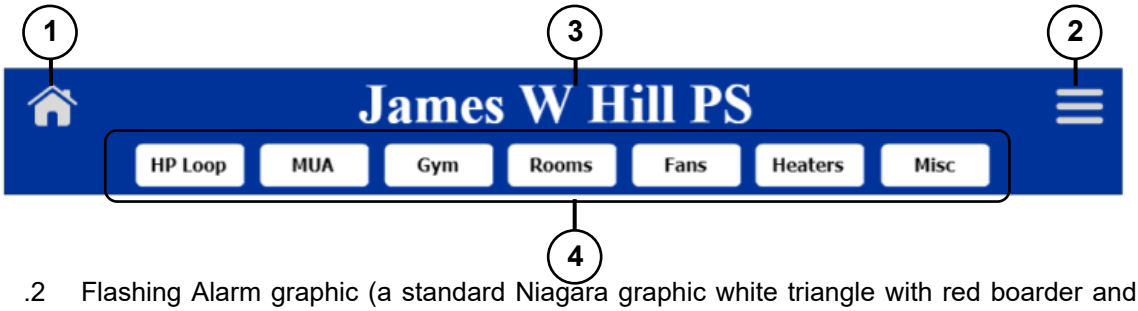
.2 All graphics shall be rendered as N4 HTML 5 views. Any graphic page that depends on JAVAbased animated widgets, or in any way depends on any browser-side-applet shall not be acceptable.

.3 The Graphical User Interface shall not use Red as graphical representation for any of the following: stop, alarm, or fault. Red is used explicitly for graphical representation of heat command and/or enable, with the only exception in text format in charts, the word “fault” can be coloured red.

.4 Graphics not explicitly detailed within this section shall be reviewed and approved by Owner.

.5 Common for all Graphics:

.1 The Header is one PX file for the entire project. All links, labels, etc. shall be edited from only one instance of the Header. The following aspects of the Header should appear exactly the same across all Board Facilities: Dimensions, Font Size, Colour(s), Equipment Navigation Buttons’ Size, Font, and Colour(s). The following shall be exactly the same 1 - Home Button, 2 - Three Line Menu Navicon. The following aspects are dynamic: 3 - Page title, and 4 - Equipment Navigation Buttons (function and name).

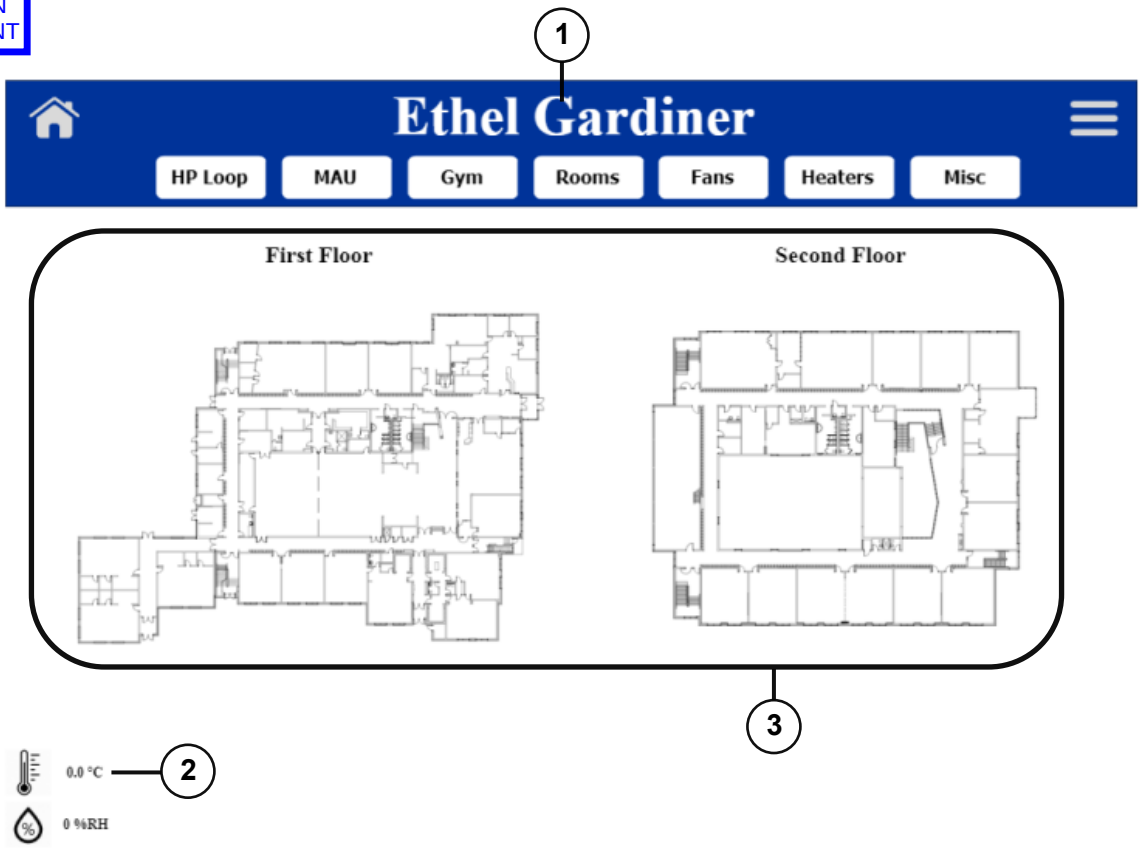


.2 Flashing Alarm graphic (a standard Niagara graphic white triangle with red boarder and black exclamation mark) shall be consistent for all alarm annunciations, across all Board facilities, regardless of vendor.

.3 Page Title shall be representative of the Navigation name used to link to the page and is to include information identifying area or equipment.

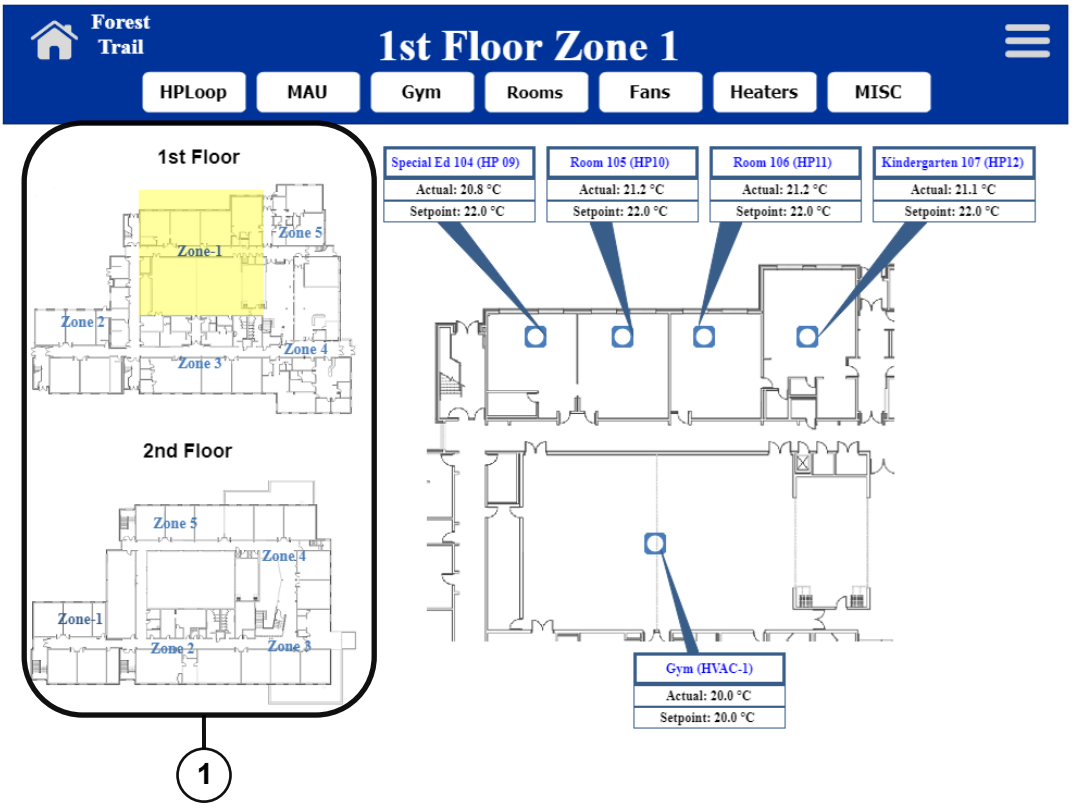
6 Home Page

The Home Page shall be comprised of the following: 1 – School / Facility name as page title, 2 - Outdoor Air Temperature, 3 - Complete Facility Floor Map (individual floors labelled accordingly).

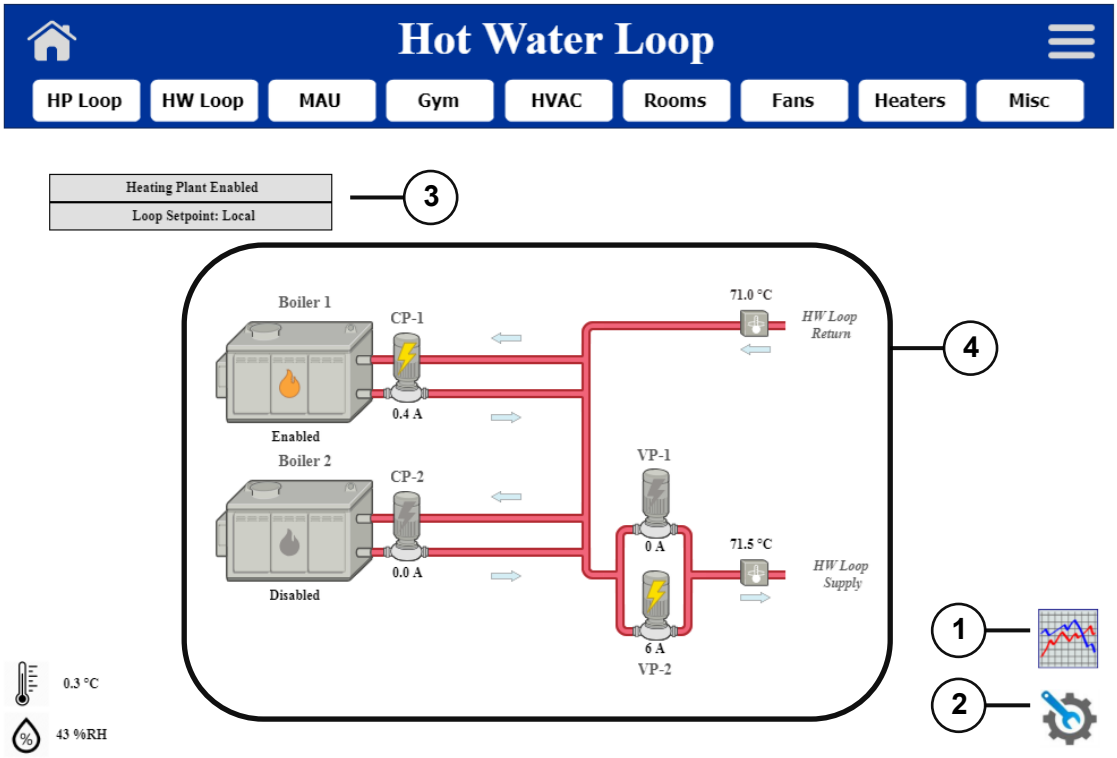


Zone

The Zone Page(s) which are scaled portions of the floor plan shall be comprised of 1 – Keyplan indicating respective zone, individual space temperatures and set-points, navigation button to respective equipment.



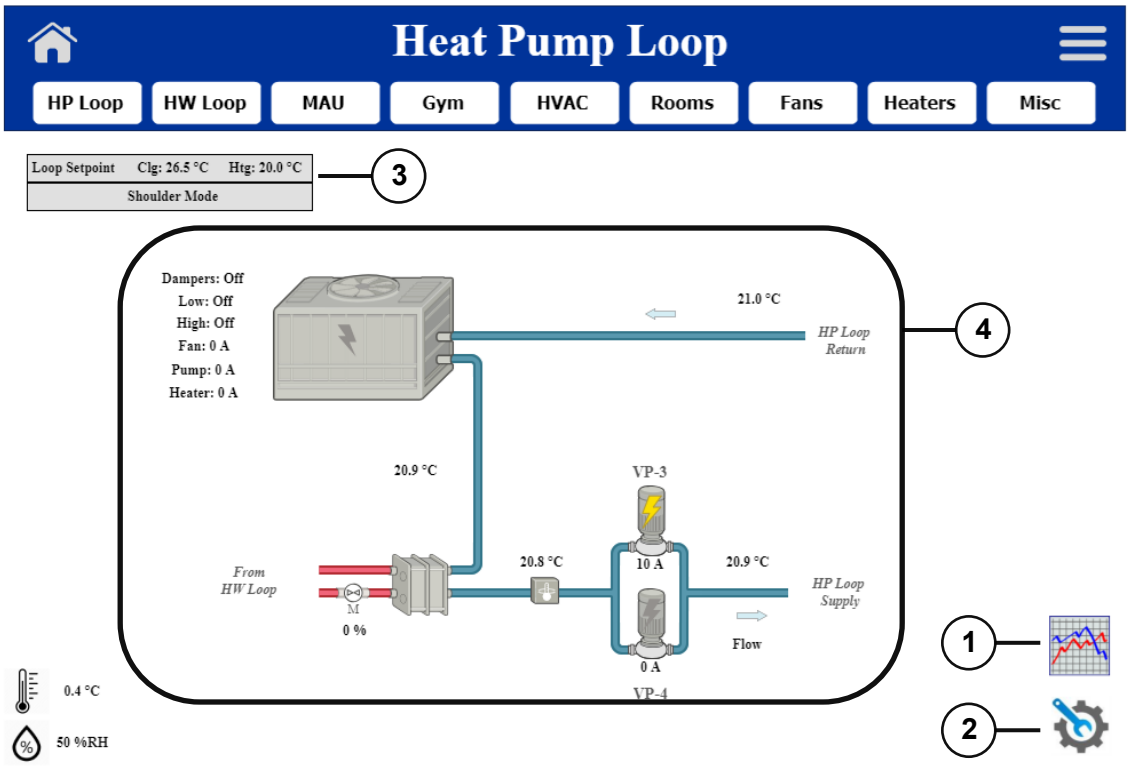
HWLoop Page
Only include HWLoop Navigation button on Header where Heating Water Loop is present at facility.
The HWLoop (Heating Water Loop) Page shall be comprised of the following: 1 - Trend navigation button (trend defaulted to include 7 days history of loop return water temperature (°C), loop supply water temperature (°C), boiler(s) supply water temperature (°C), and loop set-point (°C), 2 - Settings button to be linked to settings page, 3 - a chart with the loop water temperature set-point, and 4 – graphic depicting all associated the equipment and controlled zones. The following shall be graphically presented on the equipment: pump(s) command (green = on, white or no colour = idle), boiler command (red = on, white or no colour = idle). The following status values shall be presented: pump(s) status (amperage), valve(s) position, boiler command and reset signal value or status, boiler supply water temperature (°C), loop return water temperature (°C), loop supply water temperature (°C), zone supply water temperature (°C), zone return water temperature (°C).



.9 HPLoop Page

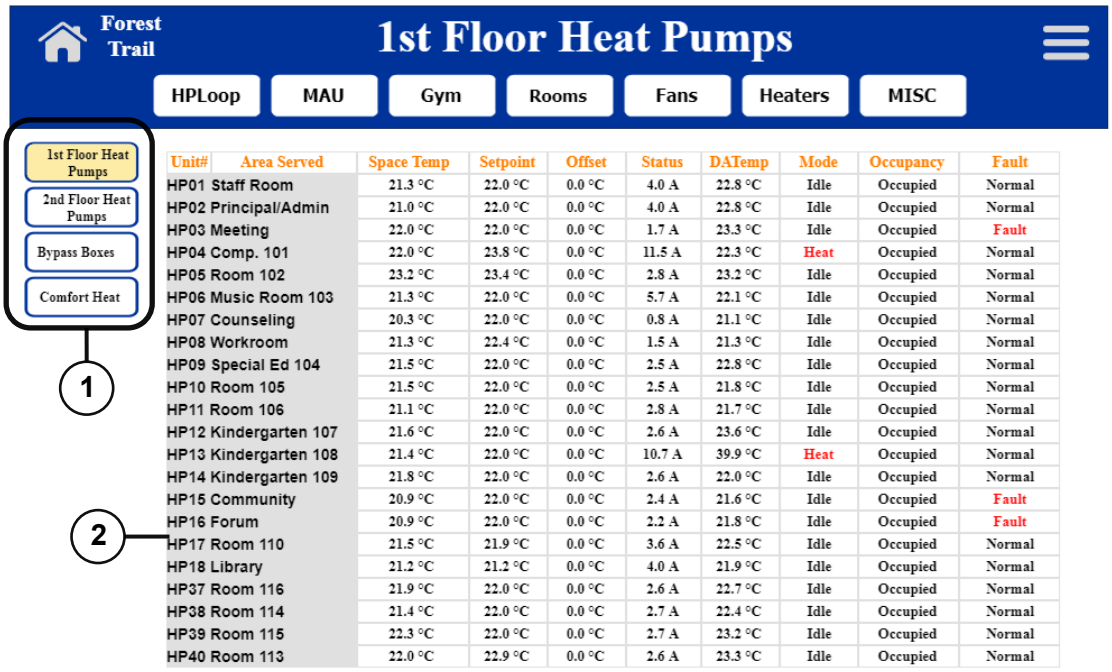
Only include HPLoop Navigation button on Header where Heat-pump Loop is present at facility.

The HpLoop (Heat-pump Loop) Page shall be comprised of the following: 1 - Trend navigation button (trend defaulted to include 7 days history of loop return water temperature (°C), loop supply water temperature (°C), cooling tower leaving water temperature (°C), and set-point (°C), 2 - Settings button to be linked to settings page, 3 - a chart with the mode, and return water temperature set-point (°C), and 4 – graphic depicting all associated the equipment and controlled zones. The following shall be graphically presented on the equipment: pump(s) command (green = on, white or no colour = idle), boiler command for dedicated Heat-pump loop boilers only (red = on, white or no colour = idle), damper(s) position. The following status values shall be presented: fan status (Amperage), cooling tower pan heater status (Amperage), pump(s) status (Amperage), valve(s) position, boiler command and reset signal value or status, boiler supply water temperature (°C), loop return water temperature (°C), loop supply water temperature (°C), cooling tower leaving water temperature (°C), cooling tower damper(s) status (open or closed), cooling tower low speed fan command, cooling tower high speed fan command, cooling tower percentage speed command where VFD installed.



10 Rooms Page

The Rooms page shall be comprised of the following: 1 - Navigation Buttons (left side of Chart) to include but not limited to: equipment by floor (example VAV Boxes 1st Floor), Comfort Heat, By-Pass Boxes, Unit Ventilators, HVAC Units. 2 – Navigation to respective equipment. Chart with live data under the following headers: Unit# (navigation to unit referenced), Area Served, Space Temp, Set-point, Offset, Status, DATemp, Mode, Occupancy, Fault.



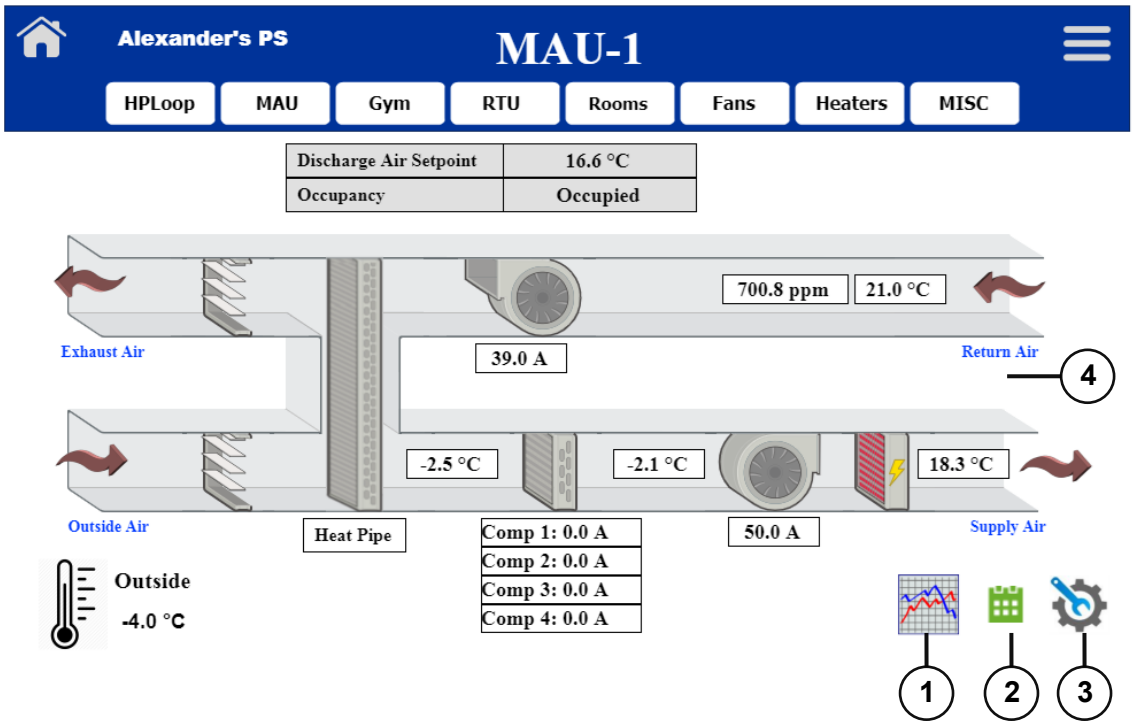
Unit#	Area Served	Space Temp	Setpoint	Offset	Status	DATemp	Mode	Occupancy	Fault
HP01	Staff Room	21.3 °C	22.0 °C	0.0 °C	4.0 A	22.8 °C	Idle	Occupied	Normal
HP02	Principal/Admin	21.0 °C	22.0 °C	0.0 °C	4.0 A	22.8 °C	Idle	Occupied	Normal
HP03	Meeting	22.0 °C	22.0 °C	0.0 °C	1.7 A	23.3 °C	Idle	Occupied	Fault
HP04	Comp. 101	22.0 °C	23.8 °C	0.0 °C	11.5 A	22.3 °C	Heat	Occupied	Normal
HP05	Room 102	23.2 °C	23.4 °C	0.0 °C	2.8 A	23.2 °C	Idle	Occupied	Normal
HP06	Music Room 103	21.3 °C	22.0 °C	0.0 °C	5.7 A	22.1 °C	Idle	Occupied	Normal
HP07	Counseling	20.3 °C	22.0 °C	0.0 °C	0.8 A	21.1 °C	Idle	Occupied	Normal
HP08	Workroom	21.3 °C	22.4 °C	0.0 °C	1.5 A	21.3 °C	Idle	Occupied	Normal
HP09	Special Ed 104	21.5 °C	22.0 °C	0.0 °C	2.5 A	22.8 °C	Idle	Occupied	Normal
HP10	Room 105	21.5 °C	22.0 °C	0.0 °C	2.5 A	21.8 °C	Idle	Occupied	Normal
HP11	Room 106	21.1 °C	22.0 °C	0.0 °C	2.8 A	21.7 °C	Idle	Occupied	Normal
HP12	Kindergarten 107	21.6 °C	22.0 °C	0.0 °C	2.6 A	23.6 °C	Idle	Occupied	Normal
HP13	Kindergarten 108	21.4 °C	22.0 °C	0.0 °C	10.7 A	39.9 °C	Heat	Occupied	Normal
HP14	Kindergarten 109	21.8 °C	22.0 °C	0.0 °C	2.6 A	22.0 °C	Idle	Occupied	Normal
HP15	Community	20.9 °C	22.0 °C	0.0 °C	2.4 A	21.6 °C	Idle	Occupied	Fault
HP16	Forum	20.9 °C	22.0 °C	0.0 °C	2.2 A	21.8 °C	Idle	Occupied	Fault
HP17	Room 110	21.5 °C	21.9 °C	0.0 °C	3.6 A	22.5 °C	Idle	Occupied	Normal
HP18	Library	21.2 °C	21.2 °C	0.0 °C	4.0 A	21.9 °C	Idle	Occupied	Normal
HP37	Room 116	21.9 °C	22.0 °C	0.0 °C	2.6 A	22.7 °C	Idle	Occupied	Normal
HP38	Room 114	21.4 °C	22.0 °C	0.0 °C	2.7 A	22.4 °C	Idle	Occupied	Normal
HP39	Room 115	22.3 °C	22.0 °C	0.0 °C	2.7 A	23.2 °C	Idle	Occupied	Normal
HP40	Room 113	22.0 °C	22.9 °C	0.0 °C	2.6 A	23.3 °C	Idle	Occupied	Normal

11

MAU Page

The MAU (make-up air unit) page shall be comprised shall be comprised of: 1 - Trend navigation button (trend defaulted to include 7 days history of return air temperature, discharge air temperature, set-point), 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, a chart with the discharge air set-point and occupancy, and 4 – template graphic depicting the equipment. The following shall be graphically presented on the equipment: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle), damper(s) position. The following status values shall be presented: fan(s) status (amperage), exhaust air temperature (°C), discharge air temperature (°C), downstream HRV/ERV air temperature (°C), heating command reset signal value or status, compressor(s) status (amperage), outdoor air damper position (where mechanically linked to return air and/or exhaust air damper(s) value to be outdoor air damper position), HRV/ERV command, HRV/ERV status

Where more than one make-up air unit exists in a facility, navigation buttons located on the left side of the graphic shall be incorporated, labelling to be determined by Owner.

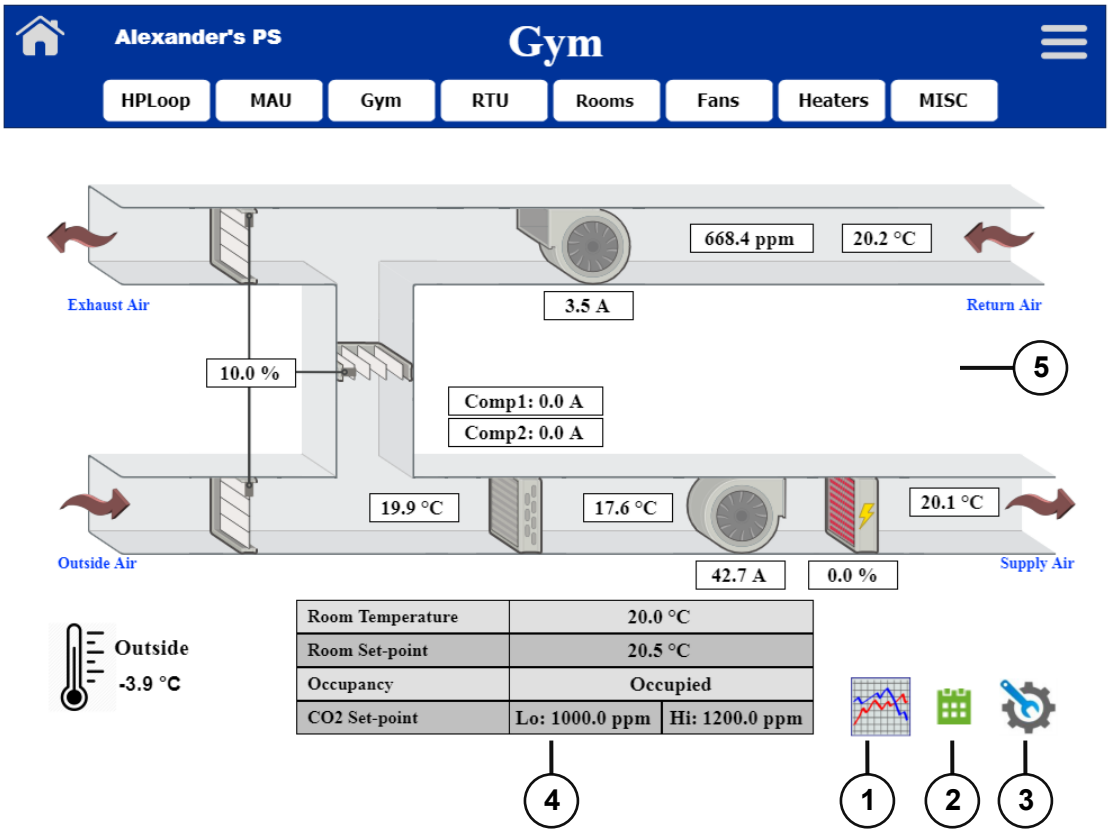


12

Gym Page

The Gym page shall be comprised of: 1 - Trend navigation button (trend to include 7 days history of return air temperature, discharge air temperature, set-point), 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, 4 - a chart with the Room Temperature, Room Set-point and Occupancy, and 5 - template graphic depicting the equipment type servicing the space. The following shall be graphically presented on the equipment graphic: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle), damper(s) position. The following status values shall be presented: fan(s) status (amperage), return air temperature (°C), discharge air temperature (°C), mixed air temperature (°C), heating command reset signal value or status, compressor(s) status (amperage), outdoor air damper position (where mechanically linked to return air and/or exhaust air damper(s) value to be outdoor air damper position), HRV/ERV command, HRV/ERV status, Where more than one piece of equipment conditions a single gymnasium, the Room Temperature, Room Set-point and Occupancy shall be a single object and programmed as such.

Where more than one gymnasium exists in a facility, navigation buttons located on the left side of the graphic shall be incorporated, labelling to be determined by Owner.

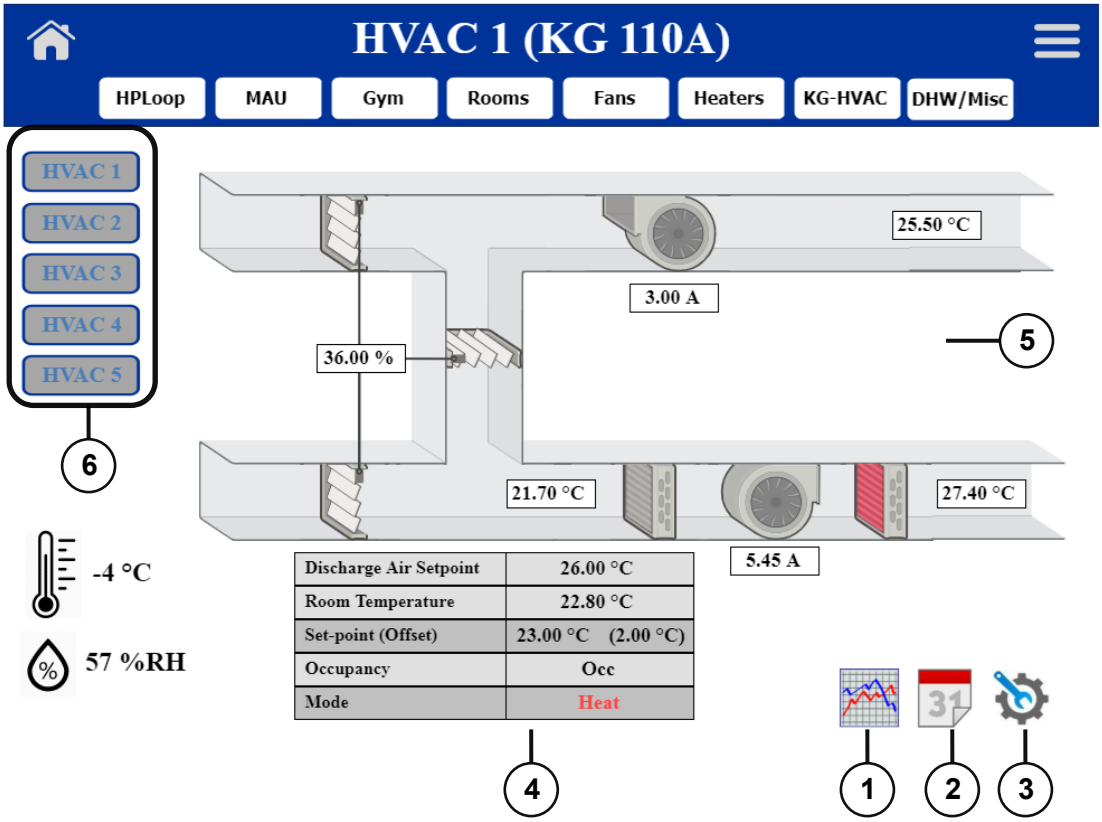


.13 HVAC Page

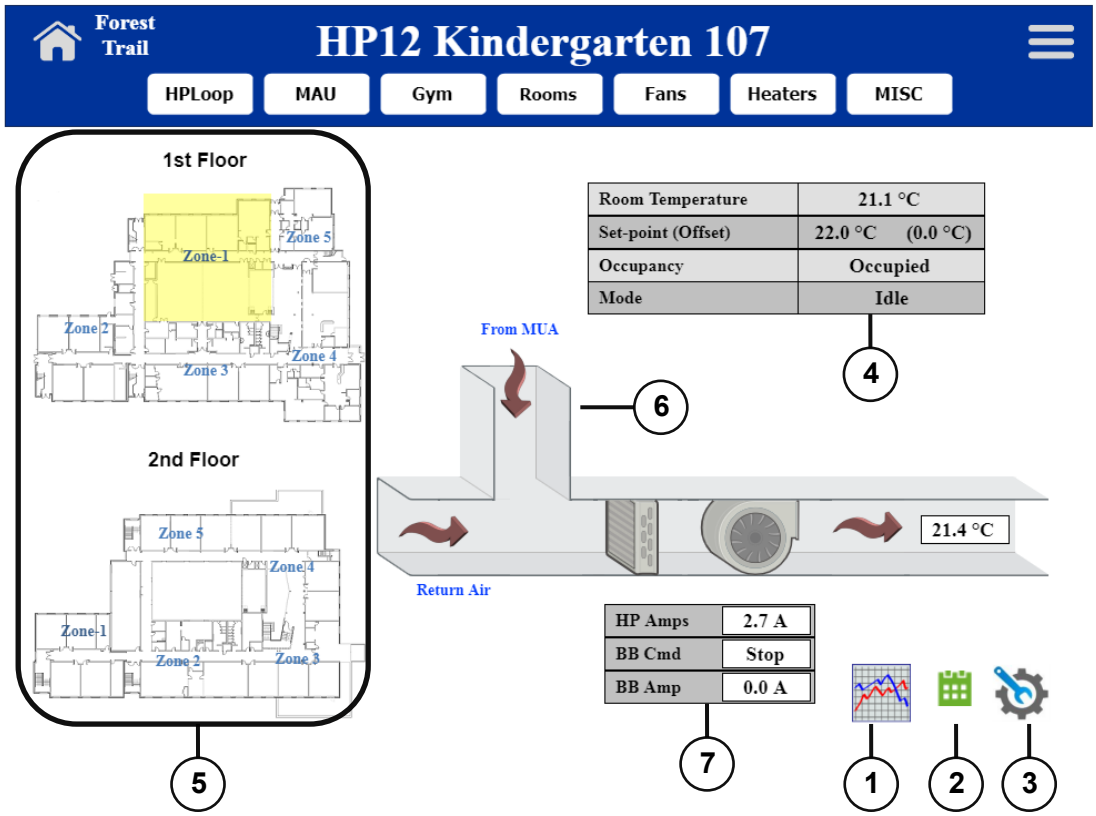
Where an HVAC Unit serves a classroom or office (which can include 1 by-pass box), an HVAC Header navigation button is not required and the unit operational information can be presented on the Rooms Page. The individual unit, navigation from chart, is to be configured per below.

Where is more than one HVAC Unit serving multiple common spaces, i.e., Library, Shop, etc., there is to be a HVAC Header navigation button used.

The HVAC page shall be comprised of: 1 - Trend navigation button (trend to include 7 days history of return air temperature, discharge air temperature, set-point, 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, 4 - a chart with the Room Temperature, Room Set-point and Occupancy, and 5 - template graphic depicting the equipment type servicing the space. The following shall be graphically presented on the equipment graphic: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle), damper(s) position. The following status values shall be presented: fan(s) status (amperage), return air temperature (°C), discharge air temperature (°C), mixed air temperature (°C), heating command reset signal value or status, compressor(s) status (amperage), outdoor air damper position (where mechanically linked to return air and/or exhaust air damper(s) value to be outdoor air damper position), HRV/ERV command, HRV/ERV status, Where more than one HVAC Unit exists in a facility, 6 - navigation buttons located on the left side of the graphic shall be incorporated, labelling to be determined by Owner.



.14 Heat-pump Page (individual equipment)
A Heat-pump page shall be comprised of: 1 - Trend navigation button (trend to include 7 days history of room temperature, set-point offset value, discharge air temperature (°C), and unit status (amperage), 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, 4 - a chart with the Room Temperature, Set-point (offset), Occupancy, and Mode, 5 – keyplan indicating zone the respective unit is located, and 6 - template Heat-pump graphic. The following shall be graphically presented on the equipment graphic: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle). The following status values shall be presented: 7 - unit status including auxiliary heat (amperage), return air temperature (°C), discharge air temperature (°C), auxiliary heat status (amperage).



.15 Fans and Heaters Page
The Fans and Heaters page(s) shall be comprised of a Chart with live data under the following headers: Unit Number, Area Served, RmTemp, Set-point, Command, Status, and Occupancy.

.16 Misc Page
The Misc page shall comprise operational information for: exterior lighting, domestic hot water status, trap flushing urinal flushing, grouped schedules, network comfort set-point.

3.15 LOW-VOLTAGE ELECTRICAL AND CONTROL WIRING

.1 It shall be the System Contractor's responsibility to complete and/or coordinate all wiring, less than 600 V, in accordance with 1.15, required for a complete Control System, including but not limited to:
- .1 All raceways, boxes, cables, circuit breakers, grounding, relays, motors, starters and wirings from existing panel boards or switchgear through splitters, starters and field disconnect switches to complete power supply required for equipment supplied under this Contract not indicated on the electrical plans and specifications.
- .2 Power to all actuators and sensors.
- .3 Provide all wiring and cabling for network communications except for owner provided LAN(s)/WAN(s).
- .4 All sensor and control device input and output wiring.
- .5 All interconnecting cabling between and amongst network devices
- .6 Interlock wiring between devices, and between motor starters.
- .7 All other necessary wiring for fully complete and functional system as specified.
- .8 Install piping, wiring/cabling routed parallel to or at right angles with the structure, properly supported every six (6) feet at a minimum and installed in a workmanlike manner.

.2 Control system wiring and cabling installed for this project shall be performed by professionals in a workmanlike manner and in accordance with National Electric Code (NFPA 70), CSA C22.2 and latest NEMA standards, FCC, and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ).

.3 All materials must be CSA and NEMA approved. Where this is not possible, arrange and pay for unconditional Electrical Safety Authority approval.

.4 The following cabling shall be installed as continuous links, including shielding. Field splices are strictly prohibited.
- .1 Network / Communication
- .2 Signal (input / output control wiring)

.5 Maximum allowable voltage for control wiring shall be 120-volts.

.6 The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site. This Section includes wiring, circuit breakers and accessories rated 600 V and less.

3.16 POWER WIRING AND CABLING

.1 Power wiring for all enclosures and equipment, including branch circuit wiring from circuit breaker panels shall be the responsibility of the System Contractor unless specifically shown on the Plans or Specifications.

.2 The B-BC panel shall be served from isolated ground receptacle via UPS by dedicated branch circuits.

.3 Power shall NOT be obtained by tapping into miscellaneous circuit that could inadvertently be switched off.

.4 Transformers and power supplies for controllers and field devices shall be supplied in accordance with manufacturers recommendations and shall be located within the designated control enclosure.

.5 Power for controls equipment shall be from a dedicated circuit. Where a controller is dedicated to controlling a single piece of equipment, power may be obtained directly from that equipment.

.6 All other enclosures, sensor and control devices shall be fed from separate circuits in the electrical distribution panels and shall not be served from the typical floor receptacle or lighting circuits.

3.17 NETWORK AND COMMUNICATION CABLING

.1 Network installation shall strictly adhere to the manufacturer's network installation instructions and procedures.

.2 All data cabling shall use stranded conductors. Solid core conductors shall not be accepted.

.3 Data cabling shall be run separately from power and signal wiring

.4 All communications wire shall be externally identified as "Building Automation System Network" in accordance with the HDSB's Building Automation Systems Standards and Design, latest revision.

.5 Network installation shall conform to standards for the LAN types and cabling types selected. Specific network rules inherent to the ANSI/AHRAE Standard 135, latest will be followed. Those include but are not limited to:

.1 Only one path can exist from any BACnet device to another
.2 The maximum length and cabling type of an MS/TP segment shall be in accordance with manufacturers specifications and shall comply with EIA-485.
.3 Each internetwork LAN must have a unique Network Number (1 - 65,545).
.4 The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard.
.5 Wire type used for MSTP, RS-485 twisted pair communications must be balanced twisted pair with 100 to 120 Ohms Characteristic Impedance. The wire shall be less than 30 pF per foot, and preferred 20 AWG or lower. A shield wire shall be included for ground connection.

.6 Primary LAN Network wire and cable shall be run separately from all other wiring.

.7 Other LAN Network wire and cabling shall be installed separate from any wiring over thirty (30) volts.

.8 All communications shielding shall be grounded as per Networked System manufacturer's recommendations.

3.18 BACNET ETHERNET COMMUNICATION CABLING

.1 Data cable shall Category 5 or better Ethernet cable.

.2 Data cable shall be four twisted pair 24 AWG solid copper, Plenum Rated FT-6 / CMP or Riser Rated FT-4 / CMR (as required by local codes) unshielded twisted cable meeting EIA / TIA 568B.1 Category 5e classification.

.3 The maximum cable length for each run shall be limited to 90 meters.

.4 All cables must be Power Sum accepted and recognized by the manufacturer.

.5 Cable Skew must be specified as 20Ns or less per 100 meters.

.6 Cables must display the manufacturer's stamp stating that the cable is included in the latest UL verified publication for respective Category standards.

3.19 SIGNAL (INPUT/OUTPUT CONTROL) WIRING

Minimum #20 AWG stranded copper conductors (larger gauge wire/cable shall be provided where required by BAS equipment and where applications warrant (e.g. rated load, long runs, etc.).

.2 All BMS input/output point wire/cable and communication cable shall be shielded.
- .1 Non-shielded cables may be approved for BAS input and output field point wiring following certification from the BAS manufacturer that non-shielded cables will function satisfactorily for the life of the building and that the use of non-shielded cables will not negatively affect other building systems/cabling.
- .2 The manufacturers certification shall guarantee to the Board that should it be determined that BAS system performance is negatively affected or another building system or equipment is negatively affected due to the non-shielded cable, the BAS manufacturer shall replace the cable at no cost to the Board.

.3 All cabling shall be installed in a neat and workman like manner. Follow manufacturer's installation recommendations for all communication cabling.

.4 Free air cabling installed in non-combustible rated buildings shall be fire rated cable with a minimum rating of FT-6.

.5 Wiring located in combustible rated buildings above T-bar ceiling shall be run in free air using fire rated cable with a minimum rating of FT-6.

.6 Note: all free air cabling used in combustible rated buildings to interface to security or fire alarm systems shall be FT-6 rated.

.7 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

.8 Cables shall follow building lines and be installed in bundles resting in a cabling support system (J-hooks).

.9 Cable supports shall be attached to the wall or ceiling of the area they are running through. Cable supports shall not be attached to:
- .1 Electrical raceways,
- .2 Duct work,
- .3 Ceiling suspension systems,
- .4 Piping,
- .5 Wilson joists.
- .6 All wire/cable terminations shall be made at screw type terminal strips. Wire nut terminations and butt splices shall not be acceptable. Wiring runs shall be continuous runs without splices.

.10 All BAS equipment and components shall be grounded to building ground facilities.

.11 BAS shall only be capable of controlling electric motors when the associated hand/off/auto (HOA) motor control switches are in the "auto" position. BAS control shall be wired into the auto circuit of the hand/off/auto motor control circuit only. Where hand/off/auto switches do not exist they shall be provided by the Controls Contractor.

.12 Life safety and equipment protection interlocks shall be wired to override equipment whenever it is in operation.

.13 Existing interlocks and override control should typically not be removed or overridden by the application of new BAS control without the specific instruction and/or approval of the Owner.

3.20 UTILITY MONITORING

.1 The metered systems include the electrical power, natural gas distribution, and water systems. The Controls Contractor is responsible for the integration and/or supply of metering equipment necessary to provide the following:
Electricity – real time and historical kWh and KW
Gas – real time and historical m3
Water – real time and historical L

.2 The Controls Contractor is responsible for coordination with the respective Electricity Provider for integration and/or installation.

.3 The Board will coordinate with Union Gas the installation of the Utility provided signal output. The Controls Contractor is responsible for connection, integration and programming.

.4 The Controls Contractor is responsible to integrate the water the existing Utility Provider's (Region of Halton) meter.

3.21 COMMISSIONING, TESTING, DEMONSTRATION, AND ACCEPTANCE

.1 The system shall be commissioned in its entirety. All commissioning and tested shall be documented and submitted prior to Demonstration and Acceptance testing. Commissioning and Testing shall include, but not limited to the following:
- .1 Verify all programming, naming, identification, and….conforms to the HDSB's Building Automation Systems Standards and Design, latest revision.
- .2 A point-to-point check of the location, installation, and labeling
- .3 Calibrate all analogue inputs and devices using actual versus the embedded UI
- .4 Control loops are to be fully set-up and tuned
- .5 Each control program and sequence shall be fully commissioned and confirmed by an end-to-end test, for the complete design intent compliance and functionality.
- .6 Verify failsafe conditions.

.2 The naming and identification of all points, networking instances, objects, meta tags, etc. is to be extracted from the site controls electronically and sent to the Owner or its Authorized representative in one of the following formats .csv, .xls or xlsx, for review and acceptance. The values are not to be edited or formatted prior to sending.

.3 Pursuant to 3.8.1, assist and cooperate with the Owner approved third party commissioning provider in the following manner: using a skilled technician who is familiar with the building, assist in the functional performance testing of the control system as per test requirements developed in the commissioning check sheets (prepared by the commissioning provider).

.4 When Commissioning, Testing, Demonstration and Acceptance process has been completed and approved and/or verified by the Owner, and within ten (10) days, the contractor will be provided with a signed letter from the owner indicating acceptance.

3.22 TRAINING

.1 Subsequent to the acceptance, per 3.9., and part of this contract, 1 day of training is to be provided to a maximum 6 individuals responsible for the operation of the site at the sole discretion of the Owner. The training shall provide instruction and demonstration on the operation, adjustment and maintenance of the BAS inclusive of all hardware and software supplied under this and other related specifications necessary to meet the functional intent.

.2 The training is to include, but not limited to, the following:
- .1 Location of all controllers, devices, sensors, peripherals, etc.
- .2 Equipment layout and dependencies
- .3 Sequence of operation
- .4 Preventative maintenance

3.23 WARRANTY, MAINTENANCE, AND SERVICE

.1 Provide warranty under provisions of these specifications.

.2 At no cost to the Owner, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

.1 Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired. Response to any request for service shall be provided within eight (8) working hours of the Owner's initial request for service. In the event that the malfunction, failure, or defect cannot be corrected through telephone support to the Owner, or its representatives, the next step is to attempt to correct the issue through remote site access. In the event the problem persists, a service technician, trained in the system to be serviced, shall be dispatched to the Owner's site within forty-eight (48) hours of the Owner's initial request for service, as specified.

.2 Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired. Response to any request for service shall be provided within two (2) working hours of the Owner's initial request for service. In the event that the malfunction, failure, or defect cannot be corrected immediately through telephone support or remote site access, a service technician, trained in the system to be serviced, shall be dispatched to the Owner's site within eight (8) hours of the Owner's initial telephone request for service, as specified.

.3 Owners Request for Service: Contractor shall specify three telephone numbers and email addresses, including order of contact and procedure in the event a contact fails to respond, for the Owner to use in the event of a need for service.

.3 Provide all labour, associated travel and expenses, materials and equipment necessary for the successful operation of this system for a period of 12 months from the date of final acceptance, per 3.9. In addition, provide three (3) visits for testing and evaluating the performance of the hardware and software installed per this specification, to be coordinated with the HDSB's Building Automation Manager. One visit shall be during the cooling season, one visit shall be during the heating season, and one visit shall be during a shoulder season, either spring or fall. Provide a written report after each visit is complete. This service visit shall include, but not be limited to, the following:

.1 Check calibration and re-calibrate if needed instrumentation sensors for air flow, liquid flow, pressure, humidity, temperature, and transducers. Written records shall be kept indicating the performance of such calibrations along with pertinent data.

.2 Check the operation of dampers and damper actuators to assure no lock up has occurred and stroke is proper. Written records shall be kept indicating the performance of such calibrations along with pertinent data.

.3 Check the overall system field operations by performing a review of all points. Verify that all monitoring and command points are valid and active. Written records shall be kept indicating the performance of such exercises.

.4 If a problem develops at any time during the warranty/service period, the affected BAS point/object shall be monitored and logged for the remainder of the warranty/service period. “A problem” in the above statement will refer to an incident in which any of the following occur:

.1 An alarm occurs due to a defective control system component(s), improper installation or programming.

.2 Overall performance of the system is compromised due to a defective control component(s), improper installation or programming.

.3 Major recalibration (by greater than 5 times the catalogued accuracy) is required for a sensor during one of the service visits.

.5 Pursuant to 3.3, changes required to meet design, compliance, and functionality, that were not part of the Demonstration and Acceptance process, will be made at no cost to the Owner.

.6 Any changes to programming, inclusive of but not limited to set-points, schedules, sequences, alarms, history, network addressing, object naming, etc. are to be performed in accordance with the Change Management Procedures outlined in the HDSB’s Building Automation Systems Standards and Design, latest revision.

3.24 SCHEDULE A

.1 Objects / Points identified in Schedule A as Mandatory (‘Y’ in Mandatory column) must be included in program of the respective system or equipment. Where an Object or Point is not listed as Mandatory, inclusion within Schedule A does not dictate the requirement for use within a program, and are listed for information purposes only where equipment differs from standard and program variations must be made to meet the sequences per 23 09 93.

.2 Objects / Points identified as Mandatory must be adjustable, in accordance with 3.12 of this Section

.3 Where a ‘G’ and/or ‘V’ is indicated in the User Interface column, the Object or Point shall be represented on the respective graphic page, in accordance with 3.9 of this Section. Mandatory points without a ‘G’ and/or ‘V’ indicated in the User Interface column shall be presented in the settings page.

.4 Where an Object or Point is identified as a software point with a ‘B’ in the Software Point column of the table, BACnet value will be an accepted means of data source provided change of value requirements are met. BACnet shall not be used as a writeable point or as a data source for Alarms classified as Emergency.

3.25 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.

3.26 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.

3.27 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.

3.28 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.

3.29 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.

END OF SECTION