TABLE OF CONTENTS

SUBMITTAL PROCEDURES

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Arrange for the preparation of clearly identified Shop Drawings as specified or as the Contract Administrator may reasonably request. Shop Drawings are to clearly indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop Drawings are to indicate their relationship to design drawings and specifications. Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract.

.2 Examine all Shop Drawings prior to submission to the Contract Administrator to ensure that all necessary requirements have been determined and verified and that each Shop Drawing has been checked and coordinated with the requirements of the Work and the Contract. Examination of each Shop Drawing shall be indicated by stamp, date and signature of a responsible person of the Subcontractor for supplied items and of the Contractor for fabricated items. Shop Drawings not stamped, signed and dated will be returned without being reviewed and stamped Re-submit".

.3 Submit Shop Drawings with reasonable promptness and in an orderly sequence so as to cause no delay in the Work. Failure to submit Shop Drawings in ample time is not to be considered sufficient reason for a change to the work schedule and no claim for extension of time by reason of such default will be allowed. Jointly prepare a schedule fixing the dates for submission and return of Shop Drawings.

.4 The Contract Administrator will review and return Shop Drawings in accordance with the schedule agreed upon or otherwise with reasonable promptness so as to cause no delay in the Work.

.5 Submit three (3) copies of white prints and three (3) copies of all fixture cut sheets and brochures.

.6 Shop Drawing review by the Contract Administrator is solely to ascertain conformance with the general design concept. Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.

.7 Review by the Contract Administrator shall not relieve the Contractor of his responsibility for errors or omissions in Shop Drawings or for proper completion of the Work in accordance with the Contract.

.8 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation and coordination of all parts of the Work rests with the Contractor.

.9 Shop Drawings will be returned to the Contractor with one of the following notations:

.1 When stamped "REVIEWED" or "NO EXCEPTIONS TAKEN", distribute additional copies as required for execution of the Work.

.2 When stamped "REVIEWED AS MODIFIED" or "MAKE NOTED CORRECTIONS", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".

.3 When stamped "REVISE & RESUBMIT", make the necessary revisions, as indicated, consistent with the Contract and submit again for review.

.4 When stamped "NOT REVIEWED" or "REJECTED", submit other drawings, brochures, etc. for review consistent with the Contract.

.5 Only Shop Drawings bearing "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS", or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.

.10 After submittals are stamped "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.

.11 Any adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of Work.

.12 Make changes in Shop Drawings which the Contract Administrator may require consistent with the Contract. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.

.13 Shop Drawings indicating design requirements not included in the Contract require the seal of a qualified Professional Engineer, registered in the province of the place of the Project. Consulting calculations shall be submitted for review, if requested, and sealed by a qualified Professional Engineer.

1.2 Samples

.1 Submit samples for the Contract Administrator’s review as specified or as the Contract Administrator may reasonably request. Clearly label samples as to origin and intended use in the Work. Reference samples to Drawings and Specifications.

.2 Submit samples with reasonable promptness and in orderly sequence so as to cause no delay in the Work. Failure to submit samples in ample time is not to be considered sufficient reason for a change to the work schedule and no claim for extension of time by reason of such default will be allowed. Jointly prepare a schedule fixing the dates for submission and return of samples.

.3 Notify the Contract Administrator in writing, at the time of submission, of any deviations in samples from requirements of the Contract.

.4 The Contract Administrator's review will be for conformity of design concept and general arrangement only. Such review is not to be considered relief of responsibility for errors or omissions in samples or of responsibility for meeting all requirements of the Contract.

.5 Any adjustments made on samples by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of the Work.

.6 Make changes in samples which the Contract Administrator may require consistent with the Contract.

1.3 Operating and Maintenance Manuals

.1 Not less than two (2) weeks prior to Substantial Performance, submit to the Contract Administrator five (5) copies of operating and maintenance manuals which shall contain information required by the Specifications as well as operational information on equipment, cleaning and lubrication schedules, filters, overhaul and adjustment schedules. All instructions in these manuals shall be in simple language to guide the City in the proper operation and maintenance of his installation.

.2 Bind contents in a three-ring, hard covered, plastic jacketed binder.

.3 Index binder according to the following system:

Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

Tab-1.1 List of Mechanical Drawings:

Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating variances, and controller operating setpoints.

Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energise switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives,

motors, and filters. Compile this information for equipment and separate from Shop Drawings.

Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

Tab-Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems.

Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

.4 The divider tabs shall be laminated Mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

1.4 Record Drawings

.1 After award of Contract, the Contract Administrator will provide a complete set of Drawings for the purpose of maintaining Project Record Drawings.

.2 Accurately record significant deviations from the Contract caused by Site conditions and changes ordered by the Contract Administrator. Update daily.

.3 Record locations of concealed elements of mechanical and electrical services.

.4 Identify Drawings as "Project Record Copy". Maintain in good condition and make available for inspection on-site by the Contract Administrator at all times.

.5 On completion of the Work and prior to final inspection, submit Record Drawings to the Contract Administrator for review.

.6 Within one (1) month after return of Record Drawings by the Contract Administrator, obtain and pay for a complete set of original reproducible sepias. Transfer all changes from Record Drawings to the sepias and certify accuracy by signing each. Deliver sepias to the Contract Administrator.

1.5 Photographs and Publicity

.1 No photographs of the Site or of any portion of the Work will be permitted without prior approval of the Contract Administrator.

.2 No press or publicity releases will be permitted without prior approval of the Contract Administrator.

END OF SECTION

REFERENCES

1. GENERAL

1.1 Abbreviations and Acronyms

.1 Within the text of the Specifications, reference may be made to the following codes, standards and organizations:

AABC	Associated Air Balance Council
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHRI	Air-Conditioning, Heating and Refrigeration Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
APHA	American Public Health Association
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASCII	American Standard Code for Information Interchange
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
AWMAC	Architectural Woodwork Manufacturers Association of Canada
AWPA	American Wood Protection Association
AWS	American Welding Society
AWWA	American Water Works Association
CBAC	Clay Brick Association of Canada
CBM	Certified Ballast Manufacturers
CCA	Canadian Construction Association
CCMC	Canadian Construction Materials Centre
CEC	Canadian Electrical Code
CEMA	Canadian Electrical Manufacturers Association

REFERENCES

CGA	Canadian Gas Association
CGSB	Canadian General Standards Board
CISC	Canadian Institute of Steel Construction
CISPI	Cast Iron Soil Pipe Institute
CITC	Canadian Institute of Timber Construction
CIU	Canadian Institute of Underwriters
CLA	Canadian Lumberman's Association
CMHC	Canada Mortgage and Housing Corporation
CPCA	Canadian Paint and Coatings Association
CPCI	Canadian Precast/Prestressed Concrete Institute
CRCA	Canadian Roofing Contractors' Association
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CSPI	Corrugated Steel Pipe Institute
CSSBI	Canadian Sheet Steel Building Institute
CWB	Canadian Welding Bureau
CWC	Canadian Wood Council
DIN	Deutsche Industrie Norm
EEI	Edison Electric Institute
EEMAC	Electrical Equipment Manufacturers Association of Canada
EFC	Electro-Federation Canada
EIA	Electronic Industries Alliance
EJMA	Expansion Joint Manufacturers Association
FCC	Federal Communications Commission (USA)
FM	Factory Mutual Engineering Corporation
IAO	Insurers' Advisory Organization
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code (ICC)
IBRM	Institute of Boiler and Radiator Manufacturers
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IEE	Institution of Electrical Engineers (UK)
IEEE	Institute of Electrical and Electronics Engineers

IES	Illuminating Engineering Society
IGMAC	Insulating Glass Manufacturers Association of Canada
ISA	Instrumentation, Systems, and Automation Society
ISO	International Organization for Standardization
LTIC	Laminated Timber Institute of Canada
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NAAMM	National Association of Architectural Metal Manufacturers
NABA	National Air Barrier Association
NACE	NACE International (formerly National Association of Corrosion Engineers)
NBC	National Building Code of Canada
NEBB	National Environmental Balancing Bureau (USA)
NEC	National Electrical Code (USA)
NECA	National Energy Conservation Association
NEMA	National Electrical Manufacturers Association (USA)
NESC	National Electric Safety Code (IEEE)
NFPA	National Fire Protection Association (USA)
NLGA	National Lumber Grades Authority
NRC	National Research Council Canada
OSHA	Occupational Safety & Health Administration (USA)
PCA	Portland Cement Association
PCI	Precast Prestressed Concrete Institute
RSIC	Reinforcing Steel Institute of Canada
SAE	Society of Automotive Engineers
SBI	Steel Boilers Institute
SI	International System of Units
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SSPC	Steel Structures Painting Council
TTMAC	Terrazzo Tile and Marble Association of Canada
UL	Underwriters Laboratories Inc.
ULC	Underwriters' Laboratories of Canada
WCB	Workers Compensation Board (Manitoba)

.2 Where specified standards are not dated, conform to latest issue of specified standards, including amendments and revisions, in effect three (3) Business Days before the Submission Deadline.

END OF SECTION

DRY-CHEMICAL FIRE-EXTINGUISHING EQUIPMENT

1. GENERAL

1.1 Scope

.1 Fire extinguishers.

.2 Fire extinguisher cabinets and mounting hardware.

1.2 General Requirements

.1 Provide portable hand extinguishers complete with cabinet where indicated on Drawings.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be approved by local Fire Commissioner.

.2 Equipment and installation shall meet the requirements of NFPA 10 Portable Fire Extinguishers.

1.4 Submittals

.1 Submit with Shop Drawings Material Safety Data Sheets for each chemical used in the Fire Extinguishers.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers

.1 Multi-Purpose Dry Chemical: Pressurised with hose and shut-off nozzle or integral shut-off nozzle and mounting brackets 4.5 kg capacity rating 4A:60BC.

2.2 Fire Extinguisher Cabinets and Brackets

.1 Fire Extinguishers Cabinet: Surface type 16 gauge steel construction with 12 gauge fully opening door in adjustable frame, 5 mm (1/5 inch) glass full panel door, approved latching device, primed and painted red.

3. EXECUTION

3.1 Installation

.1 Install extinguishers so that the bottom of extinguisher is no more than 1,200 mm above floor.

.2 All fire extinguishers shall be conspicuously and clearly marked using arrows and signs.

END OF SECTION

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational plumbing systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown. Run piping close to building structure, parallel to building lines to maximize headroom and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections.

1.2 Coordination of Work

.1 Make reference to electrical, mechanical, structural and architectural Drawings when setting out Work. Consult with respective Divisions in setting out locations for equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on-site before fabricating or installing any materials or equipment.

.2 Where dimensional details are required, work with the applicable architectural and structural Drawings.

.3 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Quality of Work

.1 All Work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Contract Administrator.

1.4 Metric Conversion

.1 All units in this Division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (in. NPS)	mm (in. NPS)	mm (in. NPS)
3 (1/8)	50 (2)	300 (12)
6 (1/4)	65 (2½)	375 (15)
10 (3/8)	75 (3)	450 (18)
15 (1/2)	100 (4)	500 (20)
20 (3/4)	125 (5)	600 (24)
25 (1)	150 (6)	750 (30)
30 (1¼)	200 (8)	
40 (1½)	250 (10)	

1.5 Salvage

.1 Remove from Site all equipment or piping which is no longer required because of Work under this Contract.

.2 Turnover and deliver to the City's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.6 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for plumbing Work.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Provide openings and holes required in precast members for plumbing Work. Cast holes 100 mm or larger in diameter. Field-cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective Section.

1.7 Excavation and Backfill

.1 Provide all excavating to facilitate installation of the plumbing Work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

1.8 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.9 Fire-Stopping

.1 Fire-stop all pipe, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The Contractor is required to coordinate with the architectural Drawings to contractual rated wall types and installation details.

.2 Fire-stopping materials to meet CAN S115. Acceptable Materials: "Tremco" or "National Firestopping", or Hilti CP680 Cast-in-Place Firestopping System.

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

1.10 Connections to Existing Services

.1 Maintain liaison with the City and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory Work is completed and all required materials are on-site. Provide a minimum of 48 hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.11 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear manufacturer’s name, address, catalogue and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

1.12 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Thoroughly clean piping and equipment of dirt, cuttings and other foreign substances.

.4 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.13 Electrical Motors

.1 Supply sump package equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.

.3 Motors less than ½ hp shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage.

.4 All motors shall be 1800 rpm except where indicated.

.5 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.6 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.7 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

1.14 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all plumbing system components including:

.1 Valves

.2 Cleanouts and traps

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm for cleanout, 300 mm x 300 mm for hand 600 mm x 600 mm for body access minimum.

.5 Provide ULC-listed fire rated access doors installed in rated wall and ceilings.

1.15 Miscellaneous Metals

.1 Provide all necessary miscellaneous metals to hang or support materials, equipment and provide access for Work under this Contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but are not limited to:

.1 Hangers for equipment and piping.

.2 Support for equipment.

1.16 Escutcheon and Plates

.1 Provide escutcheon and plates on piping passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.17 Painting and Identification

.1 Colour code plumbing equipment and piping. Refer to colour coding schedule below.

.2 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.3 Identify piping with labels, colour bands, and flow arrows. Provide identification at 3 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.4 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this section.

.5 Provide 20 mm diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.6 Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to City. Include copies in O&M Manuals.

.7 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.8 Identify electric starting switches, remote push button stations, and controls equipment supplied under this division with lamacoid plates having 6 mm (1/4 inch) minimum letter size. Identification to state equipment controlled.

.9 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including valves	black
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.18 Colour Coding Schedule

.1 Identification Symbols and Colour for Piping

	Pipe Colour	Stripe Colour	Symbol
Domestic Cold Water	Light Blue	None	Dom. Cold Wat.
Domestic Hot Water	Green	Orange	Dom. Hot Wat.
Drains	Aluminum	Red/Orange	Drain
Natural Gas	Orange	Red	Nat.Gas
Sprinkler	Red	None	Sprinkler
Stand Pipe (Dry)	Red	None	Dry Stand Pipe
Stand Pipe (Wet)	Red	None	Stand Pipe
Vent	Aluminum	Red/Orange	Vent
Water Boiler Feed	Green	Red	Blr.Feed, Over 120ºC (250ºF)
Water Boiler Feed	Green	Orange	Blr.Feed, Under 120ºC (250ºF)

.2 Plumbing Control Systems

.1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black ‘C’.

.2 Main and secondary control panels, factory finish acceptable - control Contractor to install company label to identify.

1.19 Temporary or Trial Usage

.1 Temporary or trial usage by the City or Contract Administrator of plumbing equipment supplied under Contract shall not represent acceptance.

.2 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.20 Substantial and Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Plumbing systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a Substantial Completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Water systems have been balanced with draft report submitted to the Contract Administrator.

.4 Valve tagging and equipment identification is complete.

.5 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.

.6 Draft Operating/Maintenance Manuals have been submitted.

.7 Operating and Maintenance demonstrations have been provided to the City.

.8 Written inspection report by manufacturer's representative has been submitted for noise and vibration control devices and flexible connections.

.9 Record Drawings have been submitted.

.10 All previously identified deficiencies have been corrected.

.3 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of Substantial Performance inspection have been corrected and the following items completed prior to the Total Performance inspection:

.1 Submit final water balance reports.

.2 Submit final operating and maintenance manuals.

.3 Complete final calibration.

.4 Mail warranty forms to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.4 The Contract Administrator will provide one (1) visitation for the purpose of Total Performance inspection. Subsequent visitations, if required, shall be at the expense of the Contractor.

.5 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.21 Scope

.1 Provide rough-in for and make all connections to equipment supplied by others including, but not limited to the natural gas meter.

1.22 Installation

.1 Make all plumbing connections to equipment supplied by others under this Contract. This shall include all water, drain, gas, exhaust, traps, ductwork and similar connections required. Provide isolation valves, unions, flanges and traps as required for a complete installation.

.2 Change to rough-in of services or final equipment connections due to a change in the make of equipment from that specified shall be made at no extra cost to the City, provided that

proper Shop Drawings are available for rough-in. Prior to commencing installation of rough-in for the equipment, coordinate with the final reviewed equipment Shop Drawings and with the manufacturer.

.3 Exposed piping shall be painted as per Contract Administrator's instructions.

.4 Arrange piping connections to allow for equipment removal.

2. PRODUCTS

2.1 Acceptable Manufacturers/Suppliers and Agencies

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

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

.3 The Contractor shall be fully responsible for any additional Work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.

.4 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the manufacturer whose price was carried in the Bid Opportunity. If no manufacturers names are submitted, it will be assumed that the price carried in the Bid Opportunity was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.

.5 List of Acceptable Manufacturers/Suppliers and Agencies:

.1	Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab, The Williams Brothers Corporation
.2	Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
.3	Drains - Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
.4	Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.5	Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
.6	Grooved Mechanical Pipe Joints	Victaulic, Mech Line (only where permitted)
.7	Hose Bibbs	Jenkins, Dahl, Crane, Toyo, Kitz, Mifab
.8	Insulation - Piping	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville

.9	Pipe Restraints	Trelleborg
.10	Piping Hangers and Saddles	Grinnell, Myatt
.11	Plug Cocks	DeZurik, Newman-Milliken
.12	Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
.13	Plumbing Fixtures	Crane, American Standard, Kohler
.14	Plumbing Fixtures - Prefab FRP	Aquarius, Acrylic Tubs
.15	Plumbing: Floor Drains, Roof Drains, Hose Bibbs	Mifab, Zurn, Smith
.16	Pumps - Sump	Monarch, Barnes, Hydromatic, Myers, Zoeller
.17	Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Monotight, Dresser, Lunkenheimer, Crane, Bray, Toyo, Grinnell
.18	Valves - Drain, Radiator	Jenkins, Dahl, Crane, Toyo, Kitz
.19	Valves - Eccentric Plug	DeZurik, Homestead
.20	Valves - Gate, Globe, Swing, Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee
.21	Valves - Silent Check	Val-matic, APCO, StreamFlo
.22	Vibration Isolation	Mason, Vibro Acoustic
.23	Wash Fountains	Bradley

2.2 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 ga) minimum thickness.

.2 Counterflashings are attached to plumbing equipment and lap the base flashings on the roof curbs.

.3 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.4 Vertical flange section of roof jacks shall be screwed to face of curb.

3. EXECUTION

.1 Not Applicable.

END OF SECTION

VALVES AND STRAINERS

1. GENERAL

1.1 Scope

.1 Gate valves

.2 Globe or angle valves

.3 Ball valves

.4 Check valves

.5 Plug cocks

.6 Eccentric plug valves

.7 Butterfly valves

.8 Drain valves

.9 Hose bibbs

.10 Strainers

1.2 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.3 Shop Drawings

.1 Submit copies of valves "ordering schedule" for review before ordering valves.

.2 Submit detailed Shop Drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. PRODUCTS

2.1 Domestic Cold Water System

.1 Ball Valves up to 50 mm: Brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa (600 psi) non-shock WOG rating. Threaded, Red-White Fig. 5044A. Solder joint, Red-White Fig. 5049A.

.2 Globe Valves up to 50 mm: Bronze body, screw over bonnet, threaded ends rating 1035 kPa (150 psi) steam, solder ends rating 2070 kPa (300 psi) water. Threaded, Red-White Fig. 221. Solder ends, Red-white Fig. 222.

.3 Globe Valves 65 mm and over: Cast iron body, flanged ends, OS&Y, renewable bronze seat ring, renewable composition disc. Rating 860 kPa (125 psi) steam. 1380 kPa (200psi). Red-White Fig. 400.

.4 Butterfly Valves: Cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable EPDM seat, lever lock handle operator with multiple position lock plate for valve sizes to 100 mm, heavy duty gear handwheel operator with position indicator for valve sizes 150 mm and over. Minimum rating 1200 kPa (175 psi), 121°C (250°F). Keystone F1000, F1020.

.5 Gate Valves up to 50 mm: Bronze body, inside screw, travelling stem, solid wedge, screw-in bonnet, threaded ends rating 860 kPa (125 psi) steam, solder ends rating 1380 kPa (200 psi) water. Threaded, Red-White Fig. 293. Solder ends, Red-White Fig. 299.

.6 Gate Valves 65 mm and over: Cast iron body, bronze trim, OS&Y, rising stem, solid wedge, flanged ends, rating 860 kPa (125 psi) steam. Red-White Fig. 421.

.7 Swing Check Valves up to 50 mm: Bronze body, screw-in cap, replaceable disc, 860 kPa (125 psi) steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

.8 Swing Check Valves 65 mm and over: Cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam. Red-White Fig. 435.

.9 Silent Check Valves for Pump Discharge:

.1 Up to 50 mm: Bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa (200 psi) water. Val Matic VM-S1400.

.2 65 mm and over: Wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

2.2 Domestic Water System Hose Bibbs

.1 Bronze body globe valve, renewable composition disc, threaded inlet, "garden hose" thread outlet, rating 2070 kPa (300 psi) water.

.2 Bronze or red brass, replaceable hexagonal disc, hose thread spout.

3. EXECUTION

3.1 Installation and Application

.1 Install valves with stem upright or horizontal, not inverted.

.2 Provide threaded lug type butterfly valves for equipment isolation service. Provide wafer or threaded lug type valves for zone shut-off service.

.3 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.4 Size drain lines and drain valves equal to size of apparatus drain connection.

.5 For pipe sizes 20 mm and over, minimum drain size to be 20 mm.

.6 Provide hose thread connection with cap and chain for 20 mm drain valves located in ceiling and public areas.

.7 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm where not piped directly to floor drains.

.8 Provide valved drain and hose connections off the bottom of all strainers.

END OF SECTION

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

1. GENERAL

1.1 Scope

.1 Pipe hangers and supports.

.2 Flashing for plumbing equipment.

.3 Sleeving for plumbing equipment.

.4 Pipe anchors.

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of current edition of ANSI/ASME B31.1, Power Piping.

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade; provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the Manufacturer's recommended maximum loading. Hangers shall have a 5.0 safety factor.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment. Provide sleeves for all pipe and duct penetrations through walls, ceilings, floors and footings.

.6 Dielectrically isolate dissimilar metals.

.7 Obtain approval from the Contract Administrator prior to drilling for inserts and supports for piping systems.

.8 Obtain approval from the Contract Administrator prior to using percussion type fastenings.

.9 Use of piping or equipment for hanger supports is not permitted.

.10 Use of perforated band iron, wire or chain as hangers is not permitted.

.11 Do not weld piping or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Contract Administrator.

.12 Where deemed necessary by the Contract Administrator the Contractor shall, at his own cost, employ a structural consultant to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanised steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Pipe Hangers and Supports

.1 Hangers, Pipe sizes 15 mm to 40 mm: adjustable wrought steel ring.

.2 Hangers, Pipe sizes 50 mm to 100 mm and Cold Pipe Sizes 150 mm and Over: adjustable wrought steel clevis.

.3 Hangers, Hot Pipe Sizes 150 mm and over: adjustable steel yoke and cast iron roll.

.4 Multiple or Trapeze Hangers: steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.

.5 Wall Support, Pipe Sizes to 75 mm: cast iron hook.

.6 Wall Support, Pipe Sizes 100 mm and over: welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm and over.

.7 Vertical Support: steel riser clamp.

.8 Floor Support, Pipe Sizes to 100 mm and All Cold Pipe Sizes: cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

.9 Floor Support, Hot Pipe Sizes 125 mm and over: adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

.10 Install hangers so they cannot become disengaged by movements of supported pipe.

.11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping. Provide galvanised hangers and supports for galvanised piping.

.12 Support all piping below grade and under floor slabs in 3.2 mm (1/8 in) continuous cadmium plated channel. Support channel with cadmium plated clevis hangers and rods. Install supports on centres as specified in 3.2. Extend cadmium-plated hanger rods 450 mm above slab rebar and bend back over rebar so as to provide a minimum of 450 mm of support in slab. Do not stress rod when bending.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.4 Flashing

.1 Steel Flashing: 0.55 mm (26 ga) galvanised steel.

.2 Lead Flashing: 25 kg/m² (5 lb/ft²) sheet lead for waterproofing, 5 kg/m² (1 lb/ft²) sheet lead for soundproofing.

.3 Safes: 25 kg/m² (5 lb/ft²) sheet lead or 0.5 mm (0.02 in) neoprene.

.4 Caps: Steel, 0.7 mm (24 ga) thickness minimum, 1.6 mm (16 ga) thickness at fire resistance structures.

2.5 Sleeves

.1 Pipes through Floors: Form with 1.2 mm (18 ga) galvanised steel.

.2 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with steel pipe or 1.2 mm (18 ga) thickness galvanised steel.

.3 Size large enough to allow for expansion with continuous insulation.

2.6 Pipe Seals

.1 Provide “Link-seal” pipe sealing system where passing through room foundation walls.

2.7 Finishes on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanised or factory primed with alkyd red oxide primer to CAN/CGSB-1.40.

3. EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports		Hanger Rod Diameter
	Steel	Copper	
15 mm	1.8 m (6 ft)	1.5 m (5 ft)	10 mm (0.4 in)
20 mm to 40 mm	2.1 m (7 ft)	1.8 m (6 ft)	10 mm (0.4 in)
50 mm & 65 mm	3.0 m (10 ft)	2.4 m (8 ft)	10 mm (0.4 in)
80 mm & 100 mm	3.6 m (12 ft)	3.0 m (10 ft)	16 mm (0.6 in)
150 mm to 300 mm	4.2 m (14 ft)	4.0 m (13 ft)	22 mm (¾ in)
350 mm to 450 mm	6.0 m (20 ft)	--	25 mm (1 in)

.2 Install hangers to provide minimum 12 mm (½ in) clear space between finished covering and adjacent work.

.3 Place a hanger within 300 mm of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1500 mm maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Use oversized hangers to accommodate pipe insulation thickness. For pipes up to 50 mm, use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm and over, use insulation protection saddle.

3.3 Equipment Bases and Supports

.1 Provide for floor-mounted equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor pipes immediately after vibration connections to equipment.

3.4 Flashing

.1 Flash and counterflash where plumbing equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with minimum 600 mm x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk.

.3 Flash floor drains over finished areas with lead 250 mm clear on sides with minimum 900 mm x 900 mm sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for plumbing roof installations minimum 200 mm high. Flash and counterflash with steel; solder and make waterproof.

.5 Provide continuous lead or neoprene safes below air supply casings, built-up mop sinks, shower stalls, shower room floors located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

.6 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

3.5 Sleeves

.1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeve.

.2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and duct work passing through floor, ceiling or wall, close off space between duct and sleeve and non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Piping passing through mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25 mm "flange" welded to the external face of the sleeve at the mid point of the thickness of the structure to provide a water stop.

.6 Install chrome-plated escutcheons where piping passes through finished surfaces.

END OF SECTION

PLUMBING PUMP SCHEDULE

1. PLUMBING PUMP SCHEDULE

Tag	SP-1
Function	Sump Pump
Location	Mechanical Room
Type	Packaged sump pump
Casing	Iron
Medium Pumped	Water
Design Flow Rate, L/s (USgpm)	2.2 (35)
Discharge Head, kPa (ft. water)	35.9 (12)
Inlet Size, mm (in)	100 (4)
Discharge Size	Threaded 1-1/2” NPT
Vent Size	Flanged 2” NPT
Basin Volume L (USG)	75.7 (20)
Motor Power, kW (hp)	0.2 (0.3)
Power Supply, V/ph/Hz	120/1/60
Manufacturer	Hydromatic
Model	CSS-3V
Remarks	Provide high water level alarm sent back to BMS via separate float switch

END OF SECTION

COMMISSIONING OF PLUMBING

1. GENERAL

1.1 General

.1 This Section describes the commissioning of the plumbing system.

.2 The commissioning of the plumbing system shall be in accordance with the Code of Practice for Commissioning Plumbing Systems in Buildings and as described in this section.

.3 The commissioning process shall be applied to all products, equipment and systems provided under this Division.

.4 Work specified in this section shall be performed by the Commissioning Agent, who shall be a qualified individual(s) hired by the Contractor.

1.2 Scope

.1 Demonstration of equipment and systems operations.

.2 Document all commissioning on commissioning sheets.

.3 Instruction seminars for City's personnel.

1.3 Quality Assurance

.1 Work specified shall be performed by a qualified individual(s) or Commissioning Agency specializing in this type of Work.

2. COMMISSIONING PROCESS

2.1 Duties of the Commissioning Agent

.1 The Commissioning Agent shall plan, organise and implement the commissioning process.

.2 The Commissioning Agent shall provide a complete description of the systems operation, performance and flow data to the Contract Administrator for review.

.3 The Commissioning Agent shall prepare the commissioning plan and provide demonstration and instructions to the City’s staff over a period of time to enable the staff to become familiar with the systems.

2.2 Commissioning Schedule

.1 Within one (1) month of commencing with the project work the Commissioning Agent shall review design intent and intended commissioning procedures with the Contract Administrator. One (1) month prior to the date of scheduled Substantial Performance, submit a detailed plan identifying the orderly progression of the pre-start commissioning check and subsequent commissioning performance check of each sub-system, leading up to the ultimate commissioning of entire systems.

.2 Submit a schedule for the commissioning phase of the work. This schedule shall show:

.1 Completion dates for each trade in each major section of the building.

.2 Timing of the various phases of the commissioning, testing, balancing and demonstration process.

.3 Submission dates for the various documents required prior to verification of commissioning by the Contract Administrator.

.4 Prepare a commissioning statement in which each of the four (4) phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

Phase 1 - System Readiness.

Phase 2 - System Start-up, Testing, Balancing, Etc.

Phase 3 - Verification of System Commissioning.

Phase 4 - Demonstration and Instruction.

.3 With the commissioning schedule noted above, submit a copy of all commissioning worksheets to be used during the commissioning process.

.4 Each phase is applicable to each major and separate system making up the work in Division 23 including controls and Division 26 interface as applicable.

2.3 Commissioning Phases

.1 **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

.1 Copies of all test and certificates have been submitted to the Contract Administrator.

.2 All safety controls installed and fully operational (dry run test).

.3 Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.

.4 Equipment lubrication and pre-start checks are complete.

.5 Control functional checks, including all alarms performed.

.6 Start-up verification checks by manufacturers representatives completed.

.7 All deficiencies to be recorded, reviewed by the Contract Administrator and, subsequently corrected before proceeding to the next phase, Phase 2.

.2 **Phase 2** - System Commissioning shall include but not necessarily be limited to:

.1 Activation of all systems.

.2 Testing and adjustment of all systems.

.3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the Contract Administrator and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.

.4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:

.1 Make provisions for testing flow rates.

.5 Fine Tuning:

.1 Setting up automatic controls for accurate response and precise sequencing.

.3 **Phase 3** - Verification of Commissioning.

.1 Verification of commissioning by the Contract Administrator shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 Location of and opening and closing of all access panels.

.2 Operation of all equipment and systems, under each mode of operation, including:

.1 Automatic controls.

.2 Pumps.

.2 At the completion of Phase 3, the Contractor shall submit the following to the Contract Administrator:

.1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.

.2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Contract Administrator.

.3 Record drawings as specified.

.3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Contract Administrator will provide a Certificate of Verification for Phase 3.

.4 Substantial Performance may, thereupon, be declared.

.4 **Phase 4** - Demonstration and Acceptance shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Contract Administrator and City upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

The following systems are to be commissioned:

3.1 Plumbing

.1 Domestic hot and cold water systems - system pressure tests, flush and clean lines, system pressures at fixtures, water delivery at each fixture; identification of piping systems.

.2 Sanitary drainage - system pressure tests, pipe identification.

.3 Fixtures - cleaning, test hot and cold water and drain, installation.

.4 Packaged sump system – test pumping capacity, automatic controls and alarms.

.5 Automatic trap primer system.

3.2 Fire Extinguishers

.1 Confirm fire extinguisher location and charge. Verify that all tags are filled out and signed.

3.3 General

.1 Contractor shall arrange for presentation and demonstration of plumbing equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

3.4 Demonstrations

.1 Provide three (3) working days for demonstration of equipment to the City.

.2 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

.3 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

.1 Plumbing Systems;

.4 Demonstrate the following pieces of equipment:

.1 Sump Pumps;

.2 Automatic Trap Seal Primers.

.5 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Contract Administrator one month prior to demonstration.

.6 Answer all questions raised by the City at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

END OF SECTION

SANITARY WASTE AND VENT PIPING

1. GENERAL

1.1 Quality Assurance

.1 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations latest current editions.

.2 Use welders fully qualified and licensed by Provincial Authorities.

2. PRODUCTS

2.1 Pipe

	Service	Material
.1	Sanitary drainage, and vent, inside building, above ground	DWV copper, ASTM B306 Cast iron, CSA B70
.2	Sanitary drainage, and vent, inside building, below ground	Cast iron, CSA B70 PVC-DWV, CAN/CSA B182.1
.3	Sanitary drainage and vent, outside building	Cast iron, CSA B70 PVC, SDR-35 for sizes to 300 mm, ASTM-D3034, complete with tracer wire.

2.2 Fittings and Joints

	Service	Material	Joint
.1	Sanitary drainage and vent inside building, above ground	Cast iron	Gasket clamp
		Wrought or Cast copper	Lead-free Solder
.2	Sanitary drainage and vent, inside building, below ground	Cast iron (hubless fitting)	Gasket & clamp
		PVC-DWV	Solvent weld
.3	Sanitary drainage and vent, outside building	Cast iron	Hub & spigot
		PVC- Gravity Sewer	Hub & spigot with gasket

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the Contract Administrator, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

3.2 Connection

.1 Screw joint steel piping up to and including 40 mm. Weld piping 65 mm and larger, including branch connections. Screw or weld 50 mm piping for liquid systems, weld 50 mm piping for air and gas systems.

.2 Make screwed joints with full cut standard taper pipe threads with approved non-toxic joint compound applied to male threads only.

.3 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.4 Clamp cast iron water pipe at fittings with 20 mm rods and properly anchor and support.

.5 Use grooved mechanical couplings and mechanical fasteners, only where permitted by the Contract Administrator.

.6 Use galvanised couplings with galvanised pipe.

.7 Make connections to equipment, specialty components, and branch mains with unions or flanges.

.8 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.

.9 Use insulating plastic spacers for copper pipe installation in metal studs.

3.3 Route and Grades

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25 mm dia. or line size whichever is greater and 150 mm high minimum. Square tees may only be used to assist with complete venting and draining.

.3 Make reductions in pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.

.4 Grade horizontal drainage and vent piping 2% minimum, unless noted otherwise.

3.4 Installation

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

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

END OF SECTION

PACKAGED, SUBMERSIBLE SEWERAGE PUMP

1. GENERAL

1.1 Submittals

.1 Submit with Shop Drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Show pump weights, motor and pump operating efficiencies and electrical power characteristics.

1.2 Quality Assurance

.1 Pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

2.2 Sump Basin Package

.1 Fully assembled sump basin package complete with cast iron sump pump with built-in overload protection, polyethylene basin and lid, NPT discharge and vent flanges and check valve.

2.3 Alarms

.1 Provide a separate float type high level water alarm wired back to the BMS.

3. EXECUTION

3.1 Installation

.1 Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

.2 Check and align pumps prior to start-up.

3.2 Performance

.1 Refer to the Plumbing Pump Schedule in Section 22 06 10.13.

END OF SECTION

PLUMBING EQUIPMENT

1. GENERAL

1.1 Scope

.1 Cleanouts

.2 Air chambers or water hammer arresters

.3 Floor drains

.4 Cooling equipment condensate drains

.5 Sumps

.6 Sanitary sewer service connections

.7 Water service connections

.8 Backflow preventers

.9 Vacuum breakers

.10 Backwater valves

.11 Automatic Trap Seal Primers

.12 Neutralization Tank

1.2 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide water and drainage connections to equipment furnished in other Sections of this Specification and as supplied by the City.

.3 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.4 Provide and include charges for connections to Municipal and Utility Company Service.

1.3 Submittals

.1 Submit Shop Drawings for review by the Contract Administrator, in accordance with the General Conditions. Provide Shop Drawings for the following items:

.1 Floor Drains

.2 Backflow Preventers

.3 Vacuum Breakers

2. PRODUCTS

2.1 Clean-Outs and Clean-Out Access Covers

.1 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.

.2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

2.2 Water Hammer Arresters

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20 mm minimum, and minimum 450 mm long.

.2 Install stainless steel bellows type water hammer arresters on water lines connected to solenoid valves.

2.3 Floor Drains

.1 Floor drains shall have lacquered cast iron body with double drainage flange, weep holes combined two piece body reversible clamping device and adjustable nickel/bronze strainer.

.2 Floor drains in equipment rooms shall have polished bronze funnel type strainer.

2.4 Backflow Preventer Assemblies

.1 Provide backflow preventer assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall meet current AWWA requirements and CSA B64 standards.

.2 Provide complete reduced pressure principle type assembly, consisting of pressure differential relief valve, located between two (2) positive seating replaceable check valves with stainless steel or bronze seats Watts No. 909. Provide strainer between gate valve and first check valve on units 50 mm and smaller.

.3 Provide complete double check valve type assembly consisting of two (2) positive sealing replaceable check valves with stainless steel or bronze seats. Provide check valve on units 50 mm and smaller. Watts No. 709.

.4 Provide complete atmospheric vent backflow preventer assembly, consisting of two (2) positive sealing replaceable check valves with bronze seats, integral stainer and threaded vent connection. Watts No. 9D.

2.5 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards. Watts No. 800.

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions. Watts No. 288A. For bottom inlet and outlet, Watts No. 388ASC.

.3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable. Watts No. 8A. For freezing conditions, Watts No. NF8.

2.6 Backwater Valve Assemblies

.1 Provide complete assembly, epoxy coated, cast-iron body, bronze flapper check valve, bolted access cover with neoprene gasket, heavy gauge steel epoxy coated access housing and neoprene gasketted heavy-duty nickel-bronze cover.

2.7 Automatic Trap Seal Primers

.1 Electronic automatic trap primer complete with slow closing 24 VAC solenoid valve, 120-24 VAC transformer, sediment strainer, brass ball type stop valve, brass atmospheric vacuum breaker, union and access door/mounting box for concealed installations with 15 mm copper/pex tubing connections between primer valve and floor drain. Only one (1) outlet shall be used for each drain. Standard of acceptance: Zurn Z1020.

.2 Electronic program shall provide a six (6) second water injection to traps every twenty four (24) hours.

2.8 Neutralization Tank

.1 Provide neutralization tank as described in Section 23 06 21.19 - Tank Schedule.

3. EXECUTION

3.1 Installation

.1 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.

.2 Install backflow prevention devices on plumbing lines, to code requirements, where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibbs and flush valves.

.3 Install trap primer line on all floor drains.

.4 Drainage lines shall grade 2% unless otherwise indicated on drawings.

.5 Locate plumbing vents minimum 5 m. from air intakes.

.6 Provide one neutralization tank with proper inlet and outlet heights to suit condensation discharges from two condensing boilers.

END OF SECTION

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize headroom and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections.

.7 Install control valves, control dampers, thermal wells, and other devices on piping and ducts.

1.2 Coordination of Work

.1 Make reference to electrical, plumbing, structural and architectural Drawings when setting out Work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on-site before fabricating or installing any materials or equipment.

.2 Where dimensional details are required, work with the applicable architectural and structural Drawings.

.3 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Quality of Work

.1 All Work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Contract Administrator.

1.4 Metric Conversion

.1 All units in this Division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (in. NPS)	mm (in. NPS)	mm (in. NPS)
3 (1/8)	65 (2½)	375 (15)
6 (1/4)	65 (2½)	450 (18)
10 (3/8)	75 (3)	500 (20)
15 (1/2)	100 (4)	600 (24)
20 (3/4)	125 (5)	750 (30)
25 (1)	150 (6)	
30 (1¼)	200 (8)	
40 (1½)	250 (10)	
50 (2)	300 (12)	

.5 Metric Duct Sizes:

.1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.5 Salvage

.1 Remove from Site all equipment, ducting or piping which is no longer required because of Work under this Contract.

.2 Turnover to and deliver to the City's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.6 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical Work. Cast holes 100 mm or larger in diameter. Field-cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.7 Excavation and Backfill

.1 Provide all excavating to facilitate installation of the mechanical Work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

1.8 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.9 Fire-Stopping

.1 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The Contractor is required to coordinate with the architectural drawings to contractual rated wall types and installation details.

.2 Fire-stopping materials to meet CAN S115. Acceptable Materials: "Tremco" or "National Firestopping", or Hilti CP680 Cast-in-Place Firestopping System.

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

1.10 Connections to Existing Services

.1 Maintain liaison with the City and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on-site. Provide a minimum of 48 hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.11 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear manufacturer’s name, address, catalogue and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

1.12 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.13 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.

.3 All motors intended for use with a variable speed drive (variance frequency drive) shall be inverter only rated. Variable speed drive shall be matched to motor.

.4 Two speed motors shall have separate winding for each speed.

.5 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.6 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.7 Motors less than ½ hp shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage.

.8 All motors shall be 1800 rpm except where indicated.

.9 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.10 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

.12 All motors shall be premium efficiency rated according to NEMA standards unless specified otherwise.

.13 All motors shall be inverter duty rated when driven by a variable speed drive.

1.14 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves

.2 Volume and splitter dampers

.3 Fire dampers

.4 Cleanouts and traps

.5 Controls, coils and terminal units

.6 Expansion joints

.7 Filters

.8 Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm for cleanout, 300 mm x 300 mm for hand 600 mm x 600 mm for body access minimum.

.5 Provide ULC-listed fire rated access doors installed in rated wall and ceilings.

1.15 Miscellaneous Metals

.1 Provide all necessary miscellaneous metals to hang or support materials, equipment and provide access for work under this contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but are not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

1.16 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.17 Painting and Identification

.1 Coordinate colour coding of piping and equipment with Work of Division 9.

.2 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour coding schedule below.

.3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.4 Identify piping with labels, colour bands, and flow arrows. Provide identification at 3 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.5 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this section.

.6 Provide 20 mm diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.7 Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to the City. Include copies in O&M Manuals.

.8 Tag automatic controls, instruments and relays and match/key to control shop drawing identification numbers. Tag all equipment and control panels.

.9 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this division with lamacoid plates having 6 mm (1/4 inch) minimum letter size. Identification to state equipment controlled.

.10 Identify the usage of duct access panels with self-adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

	Colour	Letters
Cleaning and service access	yellow	C.A.
Controls, including heat sensors	black	C.
Dampers (backdraft, balance & control)	blue	D.
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

Note: Provide black lettering for yellow or white background, white for all other colours.

.11 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including control dampers and valves, and heat sensors	black
Fire, smoke, and sprinkler equipment including dampers	red
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green

Balancing Dampers	blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.18 Colour Coding Schedule

.1 Identification Symbols and Colour for Piping

	Pipe Colour	**Stripe Colour**	**Symbol**
Condensate	Green	Orange	Cond.
Cooling Water Supp.	Green	Orange	Cool Wat.S.
Cooling Water Ret.	Green	Orange	Cool Wat.R.
Domestic Cold Water	Light Blue	None	Dom. Cold Wat.
Domestic Hot Water	Green	Orange	Dom. Hot Wat.
Drains	Aluminum	Red/Orange	Drain
Glycol Return	Green	Orange	Glycols R.
Glycol Supply	Green	Orange	GlycolS
Heating Hot Water Return	Yellow	Orange	Heat Wat.R.
Heating Hot Water Supp.	Yellow	Red	Heat Wat.
Vent	Aluminum	Red/Orange	Vent
Water Boiler Feed	Green	Orange	Blr.Feed, Under 120ºC (250ºF)

.2 Identification Symbols and Colours for Equipment:

	Pipe Colour	**Stripe Colour**	**Symbol**
Boilers	Green	Red	None
Motor Guards	Red Machinery Enamel		
Hangers, Brackets, Hanger Rods	Black Machinery Enamel		
Heat Exchangers	Green	Orange	None
Pumps - Regular	Aluminum	None	None
Supports	Black	None	None
Valves Uninsulated	High Heat Aluminum		

.3 Mechanical Control Systems

.1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black ‘C’.

.2 Main and secondary control panels, factory finish acceptable - control Contractor to install company label to identify.

.4 Ductwork

All ductwork in mechanical rooms to be identified as follows, complete with directional arrows:

Return Air	R.A.
Supply Air	S.A.
Mixed Air	M.A.
Combustion Air	Comb. Air
Exhaust Air	E.A.

1.19 Temporary Heat

.1 Do not use the permanent system for temporary heating purposes without written permission from the Contract Administrator.

.2 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection.

.3 Use of permanent systems for temporary heat shall not modify terms of warranty.

.4 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

.5 Air systems shall not be used for temporary heating.

.6 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company system.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.20 Temporary or Trial Usage

.1 Temporary or trial usage by the City or Contract Administrator of mechanical equipment supplied under Contract shall not represent acceptance.

.2 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.3 Avoid thermal shock to heating system by coordination with the City during planning, construction and operation of temporary heating system.

1.21 Substantial and Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Heating air conditioning, systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a Substantial Completion Inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Air and water systems have been balanced with draft report submitted to the Contract Administrator.

.4 Valve tagging and equipment identification is complete.

.5 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from Manufacturer's Representative to confirm status of treatment.

.6 Draft Operating/Maintenance Manuals have been submitted.

.7 Operating and Maintenance demonstrations have been provided to the City.

.8 Written inspection report by Manufacturer's Representative has been submitted for noise and vibration control devices and flexible connections.

.9 Record Drawings have been submitted.

.10 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.11 All previously identified deficiencies have been corrected.

.3 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Total Performance Inspection:

.1 Submit find air and water balance reports.

.2 Submit final operating and maintenance manuals.

.3 Complete final calibration.

.4 Mail warranty forms to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.4 The Contract Administrator will provide one (1) visitation for the purpose of Total Performance Inspection. Subsequent visitations if required, shall be at the expense of the Contractor.

.5 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.22 Scope

.1 Provide rough-in for and make all connections to equipment supplied by others including, but not limited to, kitchen, laundry and sterilising equipment.

1.23 Installation

.1 Make all mechanical connections to equipment supplied by others under this Contract. This shall include all water, drain, gas, exhaust, traps, ductwork and similar connections required. Provide isolation valves, unions, flanges and traps as required for a complete installation.

.2 Change to rough-in of services or final equipment connections due to a change in the make of equipment from that specified shall be made at no extra cost to the City, provided that proper Shop Drawings are available for rough-in. Prior to commencing installation of rough-in for the equipment, coordinate with the final reviewed equipment Shop Drawings and with the Manufacturer.

.3 Exposed piping shall be painted as per Contract Administrator's instructions.

.4 Arrange piping connections to allow for equipment removal.

2. PRODUCTS

2.1 Acceptable Manufacturers/Suppliers and Agencies

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

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

.3 The Contractor shall be fully responsible for any additional Work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.

.4 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the Bid Opportunity. If no manufacturers names are submitted, it will be assumed that the price carried in the Bid Opportunity was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.

.5 List of Acceptable Manufacturers/Suppliers and Agencies:

.1	Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab, The Williams Brothers Corporation
.2	Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco, Wheatley
.3	Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Anemostat, Nailor
.4	Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
.5	Balancing Agents	AMS, AHS, DFC, Airdronics

.6	Boilers – High Efficiency, Condensing	Larrs, Viessmann, Aerco, Fulton
.7	Bypass Filter (HW)	Sumco, GESL, Pace Chemicals
.8	Chimney and Breeching	Metalbestos P/S, Van Packer P/S, Metal Fab PIL
.9	Coils - Heating and Cooling	Trane, Aerofin, Engineered Air, Colmac, McQuay
.10	Controls Contractors and/or Suppliers	Johnson Controls
.11	Expansion Compensators	Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.12	Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.13	Fire Dampers	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
.14	Flexible Connectors - Ducting	Thermaflex, G.I. Industries Type IHP
.15	Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.16	Flexible Duct	Thermaflex, Wiremold, GI Industries Type H.P.
.17	Flow Meter - Orifice Plate	Gerand
.18	Flow Meter - Pitot Tube	Presco, Annubar
.19	Flow Meter - Venturi	Gerand, Presco
.20	Gauges - Air	Dwyer, Magnehelic
.21	Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
.22	Grooved Mechanical Pipe Joints	Victaulic, Mech Line (only where permitted)
.23	Heat Exchangers - Plate	Bell & Gossett, Alpha Laval, Tranter, Armstrong, APV
.24	Insulation - Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
.25	Meters, Positive Displacement	Neptune, Rockwell
.26	Pipe Restraints	Trelleborg
.27	Piping Hangers and Saddles	Grinnell, Myatt
.28	Plug Cocks	DeZurik, Newman-Milliken

.29	Pumps - In-Line Circulators	Armstrong, B & G, Taco, Grundfos
.30	Pumps – Packaged Sump	Monarch, Barnes, Hydromatic, Myers, Zoeller
.31	Pumps - Vertical In-Line	Armstrong, B & G, Taco, Leitch, Grundfos
.32	Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
.33	Tank - Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc.
.34	Thermometers	Trerice, Marsh, Ashcroft, Winters
.35	Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Monotight, Dresser, Lunkenheimer, Crane, Bray, Toyo, Grinnell
.36	Valves - Circuit Balancing	Armstrong, B & G, Wheatley, Tour & Anderson
.37	Valves - Drain, Radiator	Jenkins, Dahl, Crane, Toyo, Kitz
.38	Valves - Eccentric Plug	DeZurik, Homestead
.39	Valves - Gate, Globe, Swing, Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee
.40	Valves - Pressure Balanced Mixing	Symmons
.41	Valves - Pressure Reducing	Armstrong, Bell & Gossett, Taco
.42	Valves - Relief	Armstrong, Bell & Gossett, Taco, Wheatley
.43	Valves - Silent Check	Val-matic, APCO, StreamFlo
.44	Valves - Suction Diffusers Combination Check and Balance	Armstrong, B&G, Taco
.45	Valves - Water Pressure Reducing	Watts, Clayton, Singer, Zurn. Wilkins, BCA, Cash Acme, Braukman
.46	Vibration Isolation	Mason, Vibro Acoustic

2.2 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 ga) minimum thickness.

.2 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.3 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.4 Vertical flange section of roof jacks shall be screwed to face of curb.

3. EXECUTION

.1 Not Applicable.

END OF SECTION

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

1. GENERAL

1.1 Scope

.1 Flexible pipe connections.

.2 Expansion joints and compensators in pipe systems.

.3 Pipe loops, offsets, and swing joints.

1.2 Reference Standard

.1 Conform to current standards of Expansion Joint Manufacturers Association (EJMA) and Manufacturer's recommendations.

1.3 Shop Drawings

.1 Provide Shop Drawings for all equipment in this Section.

.2 Flexible pipe connector shop drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per 300 mm and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

.3 Expansion joint Shop Drawings shall include maximum allowable temperature and pressure rating, and maximum expansion compensation.

1.4 Inspection

.1 Provide inspection services by flexible pipe Manufacturer's Representative for final installation and certify installation is in accordance with Manufacturer's recommendations and connectors are performing satisfactorily.

2. PRODUCTS

2.1 Flexible Pipe Connectors

.1 Flexible Rubber Spools: Neoprene twin sphere connector of molded multiple plys of nylon tire cord fabric and neoprene, rated for 1035 kPa (150 psi) at 120°C (250°F). Union end connections for sizes 50 mm and under; floating galvanised ductile iron flanges for sizes over 50 mm.

.2 Spherical Rubber Spools: Neoprene single sphere elbow connector, construction and service rating same as 2.1.1 above.

.3 Braided Spools for Copper Piping: Stainless steel inner core and braid braized to copper tube ends, suitable for 1035 kPa (150 psi) at 120°C (250°F).

.4 Braided Spools for Steel Piping: Stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50 mm diameter, flanged for 65 mm diameter pipe and over. Suitable for service at 1035 kPa (150 psi) at 120°C (250°F).

2.2 Expansion Joints

.1 Copper Piping: Laminated stainless steel bellows brazed to copper tube ends, internal guide, stainless steel external shroud. Suitable for 1035 kPa (150 psi) at 260°C (500°F).

.2 Steel Piping up to 100 mm: Laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50 mm, flanged ends for sizes 65 mm and over. Internal guide and carbon steel shroud suitable for 1035 kPa (150 psi) at 260°C (500°F).

.3 Steel Piping 100 mm and over: Guided externally pressurised laminated stainless steel bellows, flanged ends, internal guide tube and ring, external shroud and guide ring. Suitable for 1035 kPa (150 psi) at 260°C (500°F).

2.3 Pipe Guides

.1 Four finger "spider" inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guide length to be minimum 300 mm.

3. EXECUTION

3.1 Application

.1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation and where indicated on the Drawing.

.2 Provide structural Work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide expansion joints where indicated or required. Where deemed necessary by the Contract Administrator the Contractor shall, at his own cost, employ a structural consultant to design pipe anchors to control piping expansion and contraction.

.3 Provide pipe guides as required to ensure correct pipe alignment for expansion joints.

3.2 Installation

.1 Install as indicated.

.2 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

.3 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.4 Install flexible connectors and expansion joints in accordance with Manufacturer's instructions.

.5 Do not compress or expand connector during installation.

END OF SECTION

METERS AND GAUGES FOR HVAC PIPING

1. GENERAL

1.1 Scope

.1 Provide meters, gauges, and taps where shown on Drawings and/or specified herein.

.2 Submit Shop Drawings of proposed products to the Contract Administrator for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Contract Administrator for review.

2. PRODUCTS

2.1 Thermometerss

.1 Dial Thermometers: 75 mm diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer.

.2 Mercury Thermometer: Red reading mercury filled, 2° graduations, aluminum case, 230 mm (9 inch) scale, straight shank, separable socket, adjustable angle.

2.2 Thermometer Well

.1 Stainless steel suitable for stem type thermometer with gasket and cap except in potable water and open systems, in which case brass type shall be used.

2.3 Pressure Gauges

.1 100 mm diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% midscale accuracy, front calibration adjustment, black figures on white background. Provide pulsating damper and pet cock for water service.

2.4 Pressure Gauge Taps

.1 Brass needle valve.

2.5 Static Pressure Gauges

.1 Dial Gauge: 100 mm dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement. Accuracy within +2% of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined Vertical Manometer: Molded plastic manometer, accuracy within +3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

3. EXECUTION

3.1 Installation

.1 Provide one pressure gauge per pump installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.2 Select gauges so that normal operating point is approximately mid-point of instrument range.

.3 On pipes 65 mm and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.2 Meters and Gauges Installation Schedule

.1 Pressure Gauges:

.1 Pumps

.2 Expansion tanks

.3 and where shown on Drawings

.2 Pressure Gauge Taps:

.1 Both sides of two-way control valves

.2 All lines to three-way control valves

.3 Major coils, inlet and outlet

.4 Heat exchangers, inlet and outlet, source and load side

.5 and where shown on Drawings

.3 Thermometers:

.1 Boiler, inlet and outlet

.2 Heat exchangers, inlet and outlet load and source side

.3 Heating water zone supply and return mains

.4 Heating and cooling coils, inlet and outlet

.5 and where shown on Drawings

.4 Thermometer Wells Only:

.1 All lines to three-way control valves

.2 and where shown on Drawings

.5 Static Pressure Gauges:

.1 Across filter banks

.2 and where shown on Drawings

.6 Static Pressure Taps:

.1 Across heating and cooling coils

.2 and where shown on Drawings

END OF SECTION

1. GENERAL

1.1 Scope

.1 Pipe hangers and supports

.2 Duct hangers and supports

.3 Flashing for mechanical equipment

.4 Sleeving for mechanical equipment

.5 Pipe anchors

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of current edition of ANSI/ASME B31.1, Power Piping.

.2 Automatic sprinkler pipe supports shall meet the requirements of current edition of NFPA No. 13, Standard for the Installation of Sprinkler Systems.

.3 Standpipe and hose system pipe supports shall meet the requirements of current edition of NFPA No. 14, Standard for the Installation of Standpipe and Hose Systems.

.4 Duct hangers shall follow the recommendations of the current edition of the SMACNA Duct Manuals.

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade; provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the Manufacturer's recommended maximum loading. Hangers shall have a 5.0 safety factor.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment. Provide sleeves for all pipe and duct penetrations through walls, ceilings, floors and footings.

.6 Dielectrically isolate dissimilar metals.

.7 Obtain approval from the Contract Administrator prior to drilling for inserts and supports for piping systems.

.8 Obtain approval from the Contract Administrator prior to using percussion type fastenings.

.9 Use of piping or equipment for hanger supports is not permitted.

.10 Use of perforated band iron, wire or chain as hangers is not permitted.

.11 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Contract Administrator.

.12 Where deemed necessary by the Contract Administrator the Contractor shall, at his own cost, employ a structural engineer to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanised steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Pipe Hangers and Supports

.1 Hangers, Pipe sizes 15 mm to 40 mm: adjustable wrought steel ring.

.2 Hangers, Pipe sizes 50 mm to 100 mm and Cold Pipe Sizes 150 mm and Over: adjustable wrought steel clevis.

.3 Hangers, Hot Pipe Sizes 150 mm and over: adjustable steel yoke and cast iron roll.

.4 Multiple or Trapeze Hangers: steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.

.5 Wall Support, Pipe Sizes to 75 mm: cast iron hook.

.6 Wall Support, Pipe Sizes 100 mm and over: welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm and over.

.7 Vertical Support: steel riser clamp.

.8 Floor Support, Pipe Sizes to 100 mm and All Cold Pipe Sizes: cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

.9 Floor Support, Hot Pipe Sizes 125 mm and over: adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

.10 Install hangers so they cannot become disengaged by movements of supported pipe.

.11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping. Provide galvanised hangers and supports for galvanised piping.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.4 Duct Hangers and Supports

.1 Conform to current edition of SMACNA handbooks.

2.5 Flashing

.1 Steel Flashing: 0.55 mm (26 ga) galvanised steel.

.2 Lead Flashing: 25 kg/m² (5 lb/ft²) sheet lead for waterproofing, 5 kg/m² (1 lb/ft²) sheet lead for soundproofing.

.3 Safes: 25 kg/m² (5 lb/ft²) sheet lead or 0.5 mm (0.02 in) neoprene.

.4 Caps: Steel, 0.7 mm (24 ga) thickness minimum, 1.6 mm (16 ga) thickness at fire resistance structures.

2.6 Sleeves

.1 Pipes through Floors: Form with 1.2 mm (18 ga) galvanised steel.

.2 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with steel pipe or 1.2 mm (18 ga) thickness galvanised steel.

.3 Ducts: Form sleeves with galvanised steel.

.4 Size large enough to allow for expansion with continuous insulation.

2.7 Pipe Seals

.1 Provide “Link-seal” pipe sealing system where passing through room foundation walls.

2.8 Finishes on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanised or factory primed with alkyd red oxide primer to CAN/CGSB-1.40.

3. EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete Work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports		Hanger Rod Diameter
	Steel	Copper	
15 mm	1.8 m (6 ft)	1.5 m (5 ft)	10 mm (0.4 in)
20 mm to 40 mm	2.1 m (7 ft)	1.8 m (6 ft)	10 mm (0.4 in)
50 mm & 65 mm	3.0 m (10 ft)	2.4 m (8 ft)	10 mm (0.4 in)
80 mm & 100 mm	3.6 m (12 ft)	3.0 m (10 ft)	16 mm (0.6 in)
150 mm to 300 mm	4.2 m (14 ft)	4.0 m (13 ft)	22 mm (¾ in)
350 mm to 450 mm	6.0 m (20 ft)	--	25 mm (1 in)

.2 Install hangers to provide minimum 12 mm (½ inch) clear space between finished covering and adjacent Work.

.3 Place a hanger within 300 mm of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1500 mm maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Use oversized hangers to accommodate pipe insulation thickness. For pipes up to 50 mm, use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm and over, use insulation protection saddle.

3.3 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750 mm wide: 25 mm x 1.6 mm (16 ga) at 3000 mm spacing.

.2 790 to 1200 mm wide: 40 mm x 1.6 mm (16 ga) at 3000 mm spacing.

.3 Over 1200 mm wide: 40 mm x 1.6 mm (16 ga) at 2400 mm spacing.

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to 450 mm wide: 40 mm x 1.6 mm (16 ga) or 25 x 25 x 3 mm (11 ga) at 2400 mm spacing.

.2 475 mm to 1000 mm wide: 40 mm x 40 mm x 3 mm (11 ga) at 1200 mm spacing.

.3 Vertical Duct on Wall Supports Minimum Sizes at 3600 mm spacing:

.1 Up to 600 mm wide: 40 mm x 1.6 mm (16 ga).

.2 625 mm to 900 mm wide: 25 mm x 25 mm x 3 mm (11 ga).

.3 925 mm to 1200 mm wide: 30 mm x 30 mm x 3 mm (11 ga).

.4 Over 1200 mm wide: 50 mm x 50 mm x 3 mm (11 ga).

.4 Vertical Duct Floor Supports Minimum Sizes, Riveted or Screwed to Ducts:

.1 Up to 1500 mm wide: 40 mm x 40 mm x 3 mm (11 ga).

.2 Over 1500 mm wide: 50 mm x 50 mm x 3 mm (11 ga).

3.4 Equipment Bases and Supports

.1 Provide for floor-mounted equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.5 Flashing

.1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with minimum 600 mm x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk.

.3 Flash floor drains over finished areas with lead 250 mm clear on sides with minimum 900 mm x 900 mm sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations minimum 200 mm high. Flash and counterflash with steel; solder and make waterproof.

.5 Provide continuous lead or neoprene safes below air supply casings, built-up mop sinks, shower stalls, shower room floors located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

.6 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to Manufacturer's data for sound control.

3.6 Sleeves

.1 Set sleeves in position in advance of concrete Work. Provide suitable reinforcing around sleeve.

.2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and ductwork passing through floor, ceiling or wall, close off space between duct and sleeve and non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Piping passing through mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25 mm "flange" welded to the external face of the sleeve at the mid point of the thickness of the structure to provide a water stop.

.6 Install chrome-plated escutcheons where piping passes through finished surfaces.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Balance, adjust, and test air and water systems and equipment and submit reports in identical units to those shown on Contract Documents.

.2 Contractor shall prepare the facility for balancing.

1.2 Quality Assurance

.1 Work specified in this Section shall be performed by an Independent Agency specialising in this type of Work, and paid by the Contractor.

.2 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.

.3 Test procedures in accordance with the current applicable portions of ASME, ASHRAE, and other recognised test codes as far as field conditions permit.

.4 Perform tests on-site to the satisfaction of the Contract Administrator.

.5 Piping or equipment shall not be concealed or covered until inspected and approved by the Contract Administrator. Provide ample written notice (two working days) to the Contract Administrator before tests.

.6 Coordinate with Contract Administrator at start of project, those tests that will require witnessing by the Contract Administrator.

.7 Use factory trained representatives and submit manufacturer's check sheets for starting the following specialty equipment.

.1 Air handling units

.2 Pumps

.3 Boilers

.4 Control components

.5 Chemical cleaning and treatment

.8 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Contract Administrator any tests required to be witnessed. Provide sufficient notice to Contract Administrator prior to commencement of procedures.

.9 Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.10 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.11 Prior to starting equipment or systems, secure and review Manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.

.12 Use Manufacturer's or Supplier's starting personnel where required to ensure integrity of Manufacturer's warranty.

.13 Compare installations to published Manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

.14 Some processes involved in starting procedures defined in this Section may be duplications of authorities' verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures. (Gas inspectors, boiler and pressure vessels inspections etc.)

.15 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE codes and standards.

.16 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.

.17 Assume all liabilities associated with starting, testing and balancing procedures.

1.3 Submittals

.1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in Operating and Maintenance Manuals.

1.4 Liability

.1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

1.5 Balancing Agenda

.1 General: Submit balancing agenda to the Contract Administrator and Commissioning Agent for review at least thirty (30) days prior to the start of balancing Work. Start balancing Work after agenda has been approved. Include descriptive data, procedure data, and sample forms in agenda.

.2 Descriptive Data: General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed and selection points for proposed sound measurements.

.3 Procedure Data: Procedures for converting test measurements to establish compliance with requirements, specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

.4 Sample Forms: Form showing application of procedures to typical systems.

1.6 Balance Report

.1 Submit two (2) copies of draft balancing reports to Contract Administrator for review.

.2 Provide copies of final reports in Operating and Maintenance Manuals.

.3 Include types, serial number and dates of calibration of instruments in the reports.

1.7 System Data

.1 The following information shall be provided:

.1 Outdoor Make-up Air Unit
Design Data:
Total air flow rate;
Fan total static pressure;
System static pressure;
Motor kW (hp), r/min, amps, volts, phase;
Outside air flow rate L/s (cfm);
Fan r/min;
Fan kW (hp);
Inlet and outlet, dry and wet bulb temperatures.

Manufacturer and model;
Size;
Arrangement discharge and class;
Motor type, kW (hp), r/min, voltage, phase, cycles, and load amperage;
Location and local identification data.

Recorded Data:
Air flow rate;
Fan total static pressure;
System static pressure;
Fan r/min;
Motor operating amperage;
Inlet and outlet, dry and wet bulb temperatures.

.2 Duct Air Quantities: All mains supplying outside air to each floor of building.

Duct sizes;
Number of pressure readings;
Sum of velocity measurements;
Average velocity;
Duct recorded air flow rate;
Duct design air flow rate.

.3 Air Inlet and Outlets
Outlet identification location and designation;
Manufacturers catalogue identification and type;
Application factors;
Design and recorded velocities;

Design and recorded air flow rates;
Deflector vane or diffuser cone settings.

.4 Pumps

Design Data:

Fluid flow rate;
Total head;
kW (hp), r/min, amps, volts, phase.

Installation Data:

Manufacturer and model;
Size;
Type drive;
Motor type, kW (hp), r/min, voltage, phase, and full load amperage.

Recorded Data:
Discharge and suction pressures (full flow and no flow);
Operating head;
Operating water flow rate (from pump curves if metering not provided);
Motor operating amps (full flow and no flow);
r/min.

.5 Expansion Tank

Design Data:

Size;
Capacity;
Pressure rating.
Installation Data:

Manufacturer, size, capacity;
Pressure reducing valve setting;
Pressure relief valve setting

.6 Heating Equipment (for existing basement and main floor heat pumps only).

Design Data:

Heat transfer rate (heating and cooling);
Fluid flow rate;
Entering and leaving fluid temperatures;
Fluid pressure drop.

Installation Data:

Manufacturer, model, type;
Entering and leaving fluid temperatures;
Capacity;
Pressure drops;

Flow rates.

Recorded Data:

Element type and identification (location and designation);
Entering and leaving fluid temp (for varying outdoor temperatures);
Fluid pressure drop;
Fluid flow rate;
Pressure relief valve setting.

.7 Heat Exchanger (plate and frame):

Design Data:

Fluid flow rates (heated media, heating media);
Fluid type;
Inlet and outlet temperatures (both source and load side).

Installation Data:

Manufacturer, model, type;
Fluid flow rates (heated media and heating media);
Inlet and outlet temperatures (both source and load side);
Pressure relief valve setting.

Recorded Data:

Heating media entering flow rate;
Heated media leaving flow rate;
Entering and leaving temperatures (for varying outdoor temperatures) and pressures;
Steam pressure and temperature, and condensate temperature.

2. PRODUCTS

2.1 Instruments

.1 Provide calibration histories for each instrument. Recalibration or use of other instruments may be requested when accuracy of readings is questionable.

3. EXECUTION

3.1 General Procedure

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.

.2 Where required by the Authority having jurisdiction, gas fired appliances rated in excess of 117 kW (400 MBH) shall be subjected to an operational test established by the Authority and shall pass this test before being approved for operation.

.3 Meet with Division 26 manufacturers, suppliers, and other specialists as required to ensure all phases of Work are properly coordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.5 Confirm voltages and operating amperages at full load.

.6 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by the City at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

.7 Permanently mark, by stick-on labels, settings on valves, splitters, dampers, and other adjustment devices.

.8 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.

.9 Balancing shall be performed to the following accuracies:

.1	Air	terminal outlets	$\pm$10%
.2	Air	central equipment	$\pm$5%
.3	Hydronic	terminal outlets	$\pm$10%
.4	Hydronic	pumps and central	$\pm$5%

3.2 Air System Procedure

.1 Perform balancing, adjusting and testing with building doors and windows in their normal operation position.

.2 The following procedure shall be adopted for central systems:

.1 Balance central apparatus to ±10% air flow.

.2 Balance branches, mains to ±10% air flow.

.3 Recheck central apparatus.

.4 Rebalance central apparatus to ±5%.

.3 Take static pressure readings and air supply temperature readings at ten (10) points on each air system.

.4 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. If readings are inconsistent across duct, relocate to two duct diameters or widths and re-do traverse.

.5 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control only by duct internal devices such as dampers and splitters.

.6 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

.7 Where modulating dampers are provided, take measurements and balance at extreme conditions. (Balance variable volume systems at maximum air flow rate - full cooling, and at minimum air flow rate - full heating).

.8 The final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurisation levels in variable volume systems throughout full range of fan delivery rates, under both heating and cooling conditions. Full multi-storey building test pressure conditions at ground, intermediate and upper levels. Front doors, exits, elevator shafts, should be checked for air flow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.

.9 Complete balancing to achieve positive building pressure unless otherwise instructed. A positive pressure relative to outside of 10 Pa (0.04 in wg) minimum and 20 Pa (0.08 in wg) maximum shall be achieved, measured with negligible outside wind velocity.

3.3 Pressure Tests

.1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests for eight-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa (5 psi) minimum and 62 kPa (10 psi) maximum.

.4 Water Piping: Test to 1-1/2 times maximum working pressure or 1033 kPa (150 psi), whichever is greater, water pressure measured at system low point.

.5 Natural Gas: Test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.

.6 Condensate Piping: Test to 690 kPa (100 psi) hydrostatic pressure.

.7 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.8 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.9 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specialising in this type of Work.

.10 Should tests indicate defective Work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.4 Radiographic Examination of Welded Joints

.1 A minimum of 10% of the welded joints unless otherwise specified elsewhere, selected by the Contract Administrator shall be examined by radiography, at Contractor's expense, as specified below.

.2 Pipe joints selected for examination shall be 100% radiographed.

.3 Examination method shall be as per current edition of ASME Code Section V, Article 2.

.4 Acceptance Criteria shall be as per current edition of ASME Code Section VIII Par UW-51. The standard of weld quality shall meet the applicable current Standard ANSI/ASME B31.1.

.5 Where a radiograph discloses defects, two additional joints shall be examined. The cost of additional radiography and the cost of repairs shall be borne by the Contractor.

3.5 Testing of Soldered Copper Joints

.1 Submit two (2) sample soldered copper pipe joints prepared by each tradesmen to be used on the project, to the Contract Administrator within two (2) months of Contract award. These samples may be subjected to radiographic testing to verify quality of workmanship.

.2 Remove ten (10) samples of soldered copper pipe joints on heating system during construction as selected by the Contract Administrator and remake joints removed. Arrange and pay for radiographic testing of removed joints to verify quality of workmanship.

.3 Rejection of a sample will require re-test of adjacent joints at the Contractor's expense.

.4 Failure of more than 75% of the above removed samples will necessitate removal and replacement of all joints completed up to the time of test, at Contractor's expense.

3.6 Balancing of Hydronic Systems

.1 Open all (except pressure bypass must be closed) valves to fully open position including balancing valves, isolation valves, and control valves.

.2 Execute air balance prior to initiating hydronic balance (if coils are provided).

.3 Adjust flows through each boiler or to ensure equal flow.

.4 Check and adjust flows and temperatures at inlet side of coils.

.5 Position and mark all automatic valves, hand valves and balancing cocks for design flow through all coils, connectors and all items in system requiring circulation of hot water or glycol.

.6 Upon completion of flow readings and coil adjustments, mark setting and record data.

.7 Coordinate shaving of impellor to operating condition on pumps larger than 1.5 kW (2 hp).

.8 Ensure all bypass valves are tightly closed.

.9 After making all terminal unit adjustments, re-check settings at pumps. Re-adjust as required.

.10 Calibrate all pressure and temperature gauges.

.11 Install pressure gauges on each coil then read pressure drop through coil and set flow rate on call for full flow through coil. Set pressure drop across bypass valve to match coil full flow pressure drop.

.12 For each pump, plot maximum and minimum flows on curve.

.13 Verify pressure drops and flows through pressure control bypass valves at full operating range.

3.7 Balancing Report

.1 Submit draft copies of reports prior to final acceptance of project.

.2 Include types, serial number and dates of calibration of instruments.

.3 Record test data on CAD Drawings made from the latest available revised set of mechanical Drawings and submit copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals. CAD drawings available from the Contract Administrator upon request.

.4 Install at each piece of mechanical equipment a "Data Register" showing significant operating temperatures, pressures, amperes, voltage, brake horsepower. "Data Register" to be enclosed in a plastic holder securely attached to the equipment or to a wall in the adjacent area.

.5 Submit with report, fan and pump curves with operating conditions plotted.

.6 Report will be indexed as follows:

Air
Summary
Procedure
Instrumentation
Drawings
Equipment Summary
Fan Sheets
Fan Curves
Fan Profile Data
Static Data
Air Monitoring Station Data
Traverse Data and Schedule

Terminal Unit Summary
Outlet Data Summary and Schematics (per system)
Building Pressurisation Data Diagnostic
Water
Summary
Procedure
Instrumentation
Drawings
Pump Data
Pump Curves
Flow Stations
Coils
Equipment Data
Element Data Summary and Schematics (per system)
Diagnostic

3.8 Bring the work to an operating state and ready for balancing, including:

.1 Clean equipment.

.2 Replace filters with specified filters prior to balancing.

.3 Verify lubrication of equipment.

.4 Install permanent instrumentation.

.5 Clean piping systems and strainers, clean systems, drain and fill with clean heat exchange fluid.

.6 Complete the "start-up" of equipment.

.7 Adjust stuffing boxes and packing glands on pumps and valves.

.8 Check rotation and alignment of rotating equipment and tension of belted drives.

.9 Set control points of automatic apparatus, check-out sequence of operation.

.10 Make available control diagrams and sequence of operation.

.11 Clean Work, remove temporary tags, stickers, and coverings.

.12 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

3.9 Balancing Valves and Dampers

.1 Provide and install balancing valves, dampers, and other materials requested by the Balancing Agency and/or necessary to properly adjust or correct the systems to design flows, without additional cost to the City.

3.10 Pulleys and Sheaves

.1 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, without additional cost to the City.

3.11 Shaving of Pump Impellers

.1 Allow in the Contract price shaving of impellers as required to balance the pumps to design flow at operating condition.

END OF SECTION

1. HYDRONIC PUMP SCHEDULE

Tag	P-8	P-10	P-11
Function	To Heat Exchanger	Building Loop	Building Loop
Location	Mechanical Room	Mechanical Room	Mechanical Room
Type	Vertical Inline	Vertical Inline	Vertical Inline
Impeller	Brass	Brass	Brass
Casing	Cast Iron	Cast Iron	Cast Iron
Medium Pumped	Water	Water	Water
Design Pressure, kPa (psi)	1034 (150)	1034 (150)	1034 (150)
Maximum Operating Temp., ºC (ºF)	1207 (175)	1207 (175)	1207 (175)
Pump Speed, RPM	1750	1150	1150
Design Flow Rate, L/s (USgpm)	2.52 (40)	6.93 (110)	6.93 (110)
Discharge Head, kPa (ft. water)	74.6 (25)	59.7 (20)	59.7 (20)
Suction/Discharge Sizes, mm (inch)	(1.5/1.5)	(2.5/2.5)	(2.5/2.5)
Motor Power, kW (hp)	0.56 (0.75)	1.12 (1.5)	1.12 (1.5)
Power Supply, V/ph/Hz	208/3/60	208/3/60	208/3/60
Manufacturer	Bell & Gossett	Bell & Gossett	Bell & Gossett
Model	Series “90” 1-1/2A	Series “80” 2.5x2.5x9.5B	Series “80” 2.5x2.5x9.5B
Weight, Kg (lb)	34 (75)	97.7 (215)	97.7 (215)
Remarks	ODP Motor	ODP Motor	ODP Motor

HYDRONIC PUMP SCHEDULE

Tag	P-12	P-13
Function	To Existing Building	To pre-heating Coil
Location	Mechanical Room	Mechanical Room
Type	Inline Booster	Inline Booster
Impeller	30% Glass filled Noryl	30% Glass filled Noryl
Casing	Cast Iron	Cast Iron
Medium Pumped	Water	50% Ethylene Glycol
Design Pressure, kPa (psi)	1034 (150)	1034 (150)
Maximum Operating Temp., ºC (ºF)	1034 (150)	1034 (150)
Pump Speed, RPM	3200	3250
Design Flow Rate, L/s (USgpm)	5.04 (80)	1.77 (28.1)
Discharge Head, kPa (ft. water)	14.9 (5)	74.6 (25)
Suction/Discharge Sizes, mm (inch)	(2/2)	(1.5/1.5)
Motor Power, kW (hp)	0.3 (0.4)	0.3 (0.4)
Power Supply, V/ph/Hz	230/1/60	230/1/60
Manufacturer	Bell & Gossett	Bell & Gossett
Model	PL-130	PL-55
Weight, Kg (lb)	12.3 (27)	5.9 (13)
Remarks	ODP Motor	ODP Motor

END OF SECTION

CIRCUIT BALANCING VALVE SCHEDULE

1. CIRCUIT BALANCING VALVE

Tag	CBV-B-1	CBV-B-2	CBV-1-1
Related Equipment	Heat Pump B-1	Heat Pump B-2	Heat Pump 1-1
Connection Type	NPT	NPT	NPT
Maximum Working Pressure, kPa (psi)	2068 (300)	2068 (300)	2068 (300)
Operating Temperature Range, ºC (ºF)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)
Medium Handled	Water	Water	Water
Flow Rate Setpoint, L/s (USgpm)	0.95 (15.0)	0.95 (15.0)	0.66 (10.5)
Pipe Connection Size, mm (in)	40 (1.5)	40 (1.5)	30 (1.25)
Drain Port Size, mm (in)	/	/	/
Manufacturer	Armstrong	Armstrong	Armstrong
Model	CBV150VT	CBV150VT	CBV-125VT

Tag	CBV-1-2	CBV-1-3	CBV-1-4
Function	Heat Pump 1-2	Heat Pump 1-3	Heat Pump 1-4
Connection Type	NPT	NPT	NPT
Maximum Working Pressure, kPa (psi)	2068 (300)	2068 (300)	2068 (300)
Operating Temperature Range, ºC (ºF)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)
Medium Handled	Water	Water	Water
Flow Rate Setpoint, L/s (USgpm)	0.66 (10.5)	0.26 (4.4)	0.26 (4.4)
Pipe Connection Size, mm (in)	30 (1.25)	25 (1.0)	25 (1.0)
Drain Port Size, mm (in)	/	/	/
Manufacturer	Armstrong	Armstrong	Armstrong
Model	CBV-125VT	CBV-100VT	CBV-100VT

CIRCUIT BALANCING VALVE SCHEDULE

Tag	CBV-1-5	CBV-1-6	CBV-1-7
Function	Heat Pump 1-5	Heat Pump 1-6	Heat Pump 1-7
Connection Type	NPT	NPT	NPT
Maximum Working Pressure, kPa (psi)	2068 (300)	2068 (300)	2068 (300)
Operating Temperature Range, ºC (ºF)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)
Medium Handled	Water	Water	Water
Flow Rate Setpoint, L/s (USgpm)	0.57 (9.0)	0.38 (6.0)	0.26 (4.4)
Pipe Connection Size, mm (in)	30 (1.25)	25 (1.0)	25 (1.0)
Drain Port Size, mm (in)	/	/	/
Manufacturer	Armstrong	Armstrong	Armstrong
Model	CBV-125VT	CBV-100VT	CBV-100VT

Tag	CBV-P-8	CBV-P-10	CBV-P-12
Function	High Temp. Loop	Low Temp. Loop	High Temp. Loop
Connection Type	Grooved	Grooved	Grooved
Maximum Working Pressure, kPa (psi)	1724 (250)	1724 (250)	1724 (250)
Maximum Operating Temperature, ºC (ºF)	110 (230)	110 (230))	110 (230)
Medium Handled	Water	Water	Water
Flow Rate Setpoint, L/s (USgpm)	2.52 (40)	6.93 (110)	5.04 (80)
Pipe Connection Size, mm (in)	65 (2.5)	100 (4.0)	75 (3)
Two Drain Tappings, mm (in)	6 (0.25)	6 (0.25)	6 (0.25)
Manufacturer	Armstrong	Armstrong	Armstrong
Model	CBV-GS or CBV-GA	CBV-GS or CBV-GA	CBV-GS or CBV-GA

CIRCUIT BALANCING VALVE SCHEDULE

Tag	CBV-P-13	CBV-F-1	CBV-F-1
Function	Glycol Loop	Future Heat Pump	Future Heat Pump
Connection Type	NPT	NPT	NPT
Maximum Working Pressure, kPa (psi)	2068 (300)	2068 (300)	2068 (300)
Operating Temperature Range, ºC (ºF)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)	-20 to150 (-4 to 300)
Medium Handled	50% Ethylene Glycol	Water	Water
Flow Rate Setpoint, L/s (USgpm)	1.78 (28.1)	0.95 (15.0)	0.95 (15.0)
Pipe Connection Size, mm (in)	50 (2.0)	40 (1.5)	40 (1.5)
Drain Port Size, mm (in)	/	/	/
Manufacturer	Armstrong	Armstrong	Armstrong
Model	CBV-200VT	CBV150VT	CBV150VT

END OF SECTION

PLATE AND FRAME HEAT EXCHANGER SCHEDULE

1. PLATE AND FRAME HEAT EXCHANGER SCHEDULE

Tag	HX-1
Location	Mechanical Room
Type	Plate & Frame
Load Side	
Medium	50% Ethylene Glycol
Design Flow, l/s (USgpm)	1.78 (28.14)
Entering Water Temp, °C (ºF)	31.8 (89.3)
Leaving Water Temp, °C (ºF)	37.8 (100)
Pressure Drop, kPa (psi)	24.4 (3.54)
Connection size, NPT	50 (2) In / 50 (2) Out
Source Side	
Medium	Water
Design Flow, l/s (USgpm)	0.89 (14.13)
Entering Water Temp, °C (ºF)	57 (135)
Leaving Water Temp, °C (ºF)	46.9 (116.35)
Pressure Drop, kPa (psi)	5.65 (0.82)
Connection size, NPT	50 (2) In / 50 (2) Out
Heat Exchanged, kW (MBH)	38 (130)
Number of Plates Source/Load	11/39
Effective Heat Transfer Surface m2 (ft2)	0.66 (7.12)
Plate Material / Thickness, mm (in)	AISI 316 / 0.5 (0.02)
Dimensions LxWxH, mm (in) (Length includes carry length)	520x305x570 (20.5x12x22.3)
Max. Design Pressure., kPa (psi)	1034 (150)
Manufacturer	ITT

END OF SECTION

TANK SCHEDULE

1. EXPANSION TANK SCHEDULE

Tag	ET-1	ET-2
Service	Glycol System	Hot Water System
Location	Mechanical Room	11th Floor
Type	Expansion	Expansion
Tank Volume, L (USgal)	30 (8)	168 (44.5)
Acceptance Volume, L (USgal)	9 (2.4)	86 (22.6)
Diameter, mm (in)	305 (12)	610 (24)
Height, mm (in)	495 (19.5)	705 (29)
System Connection, mm (in)	15 (0.5)	25 (1)
Manufacturer	Amtrol	Amtrol
Model	AX-15V	AX-80V
Accessories & Remarks	Provide pressure gauge and automatic air vent	Provide pressure gauge and automatic air vent

2. GLYCOL FILL TANK SCHEDULE

Tag	GFT-1
Service	Glycol System
Location	Mechanical Room
Type	Glycol Fill Tank
Tank Volume, L (USgal)	208 (55)
Diameter, mm (in)	610 (24)
Height/Length, mm (in)	1245 (49)
System Connection, mm (in)	15 (0.5)
Manufacturer	Axiom
Model	SF-100
Electrical, V/ph/Hz	115/1/60
Accessories & Remarks	c/w full tank of pre-mixed 50% EG

3. NEUTRALIZATION TANK SCHEDULE

Tag	AN-1
Service	Drainage System
Location	Mechanical Room
Type	Neutralization Tank
Tank Volume, L (USgal)	170 (45)
Effective Volume, L (USgal)	57 (15)
Diameter, mm (in)	560 (22)
Height/Length, mm (in)	840 (33)
System Connection, mm (in)	/
Manufacturer	Watts
Model	T5
Accessories & Remarks	

4. AIR SEPARATOR SCHEDULE

Tag	AS-1	AS-2
Service	Water System	Glycol System
Location	Mechanical Room	Mechanical Room
Type	Tangential c/w Strainer	Tangential c/w Strainer
Fluid Velocity, m/s	1.2	1.2
Flow Rate, L/S (USgpm)	10 (160)	2.7 (42)
Diameter, mm (in)	305 (12)	254(10)
Height, mm (in)	622 (24.5)	584 (23)
Overall Width, mm (in)	530 (20.75)	415 (16.25)
Distance to Remove Strainer , mm (in)	420 (16.5)	356 (14)
In/Out Sizes, mm (in)	100 (4)	50 (2)
Manufacturer	Amtrol	Amtrol
Model	4-AS-L	2-AS-L

END OF SECTION

1. CONDENSING BOILER SCHEDULE

Tag	B-3	B-4
Manufacturer	LAARS	LAARS
Model	NT 399	NT 399
Heating Input, kW (MBH)	117(399)	117(399)
Rated Heating Output, kW (MBH)	112 (382)	112 (382)
Operating Pressure, kPa (psi)	1034 (150)	1034 (150)
EWT, °C (°F)	49 (120)	49 (120)
LWT, °C (°F)	60 (140)	60 (140)
Flow Rate, L/s (gpm)	2.4 (38)	2.4 (38)
Pressure drop, kPa (Ft Hd)	83.6 (28)	83.6 (28)
Fuel Source	Natural Gas	Natural Gas
Turn Down Ratio	5:1	5:1
Gas Connections (NPT), mm (in)	20 (0.75)	20 (0.75)
Water Connections (NPT), mm (in)	30 (1.25)	30 (1.25)
Air Intake Size, mm (in)	100 (4)	100 (4)
Vent Size, mm (in)	100 (4)	100 (4)
Electrical, V/ph/Hz	120/1/60	120/1/60
Electrical Circuit Required	Minimum 15 amp	Minimum 15 amp
Gross Weight, kg (lbs)	(405)	(405)
WxDxH, mm (in)	800x480x970 (31.5x19x38)	800x480x970 (31.5x19x38)
Remarks	ASME Approved, Supplied with boiler pump, 150 psi pressure relief valve, water flow switch, low water cutoff and air terminal kit (#2400-102 or 40D5025).	ASME Approved, Supplied with boiler pump, 150 psi pressure relief valve, water flow switch, low water cutoff and air terminal kit (#2400-102 or 40D5025)

END OF SECTION

1. AIR COIL SCHEDULE

Tag	PHC-1
Location	MUA
Coil Model	McQuay 5WB0601B
Total Capacity, kW (MBH)	37.7 (128.78)
Air Data	
Airflow, L/s (cfm)	2900 (6144)
EAT, °C (°F) db	-40 (-40)
LAT, °C (°F) db	-29 (-20.8)
Total Face Area, m^2 (sq. ft.)	1.4 (15.0)
Max. Face Velocity, m/s (fpm)	2.08 (410)
Rows	1
Fin Spacing, fpi	6
Dimension (H x L), mm (in)	904x 1524 (36x60)
Max. Air P.D., Pa (in wg)	12.5 (0.05)
Fluid Data	
Flow, L/s (gpm)	1.8 (28.1)
EWT, °C (°F)	37.8 (100)
LWT, °C (°F)	31.8 (89.3)
PD, kPa (ft wg)	21.5 (7.2)
Fluid Type	50% Ethylene Glycol
Connection Size (Threaded), mm (in)	40 (1.5) In / 40 (1.5) Out
Overall Dimension WxHxT, mm (in)	1820x990x130 (71.5x39x5)
Operation Weight kg (lb)	51 (112)
Remarks	Galvanized Steel case

END OF SECTION

HVAC PIPING INSULATION

1. GENERAL

1.1 Scope

.1 Piping insulation

.2 Adhesives, tie wires, tapes

.3 Recovering

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workers regularly engaged in this type of Work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating and recovering materials.

1.4 Job Conditions

.1 Deliver material to Site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

2. PRODUCTS

2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.3 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 Materials

.1 Hot Piping: Formed fine fibrous glass or mineral fibre pipe insulation, with factory applied general purpose jacket, factory moulded to conform to piping, "K" value maximum 0.035 W/m°C (0.25 Btu-in/(hr-ft^2-°F)) at 24°C (75°F). Service temperature up to 150°C (300°F).

.2 Recovery Jackets:

.1 ULC labelled thermo-canvas flamespread less than 25 smoke developed less than 50.

.2 0.4 mm (30 ga) smooth aluminum sheet for piping.

.3 Cold and hot water piping up to 116ºC (240ºF): as an alternate to formed fibreglass pipe insulation, rigid phenolic closed cell foam insulation equal to Kingspan Koolphen K CFC-free rigid phenolic insulation may be used. Product shall meet ASTM-E-84 and ASTM-C-585-90 and ULC burn and smoke spread rating for non-combustible installations (ULC-S102, S127).

3. EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.2 Insulate complete system including fittings, valves, unions, flanges, strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with plastic material travelled on a bevel.

.3 Insulate piping, fittings and valves. Do not insulate unions, flanges (except on flanged valves), "victaulic" couplings, strainers, (except on chilled water lines), flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.4 Finish insulation neatly on hangers, supports and other protrusions.

.5 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.6 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawlspaces, pipe shafts and suspended ceiling spaces is not considered exposed. Make smooth uneven insulated surfaces before recovering.

.7 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.8 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100 mm centres.

.9 Hot Piping: for fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells.

3.3 Insulation Installation Thickness Schedule

.1 All piping identified in the following table shall be insulated and jacketed except as noted on Drawings.

Piping or Equipment		**Pipe Sizes, mm**	**Insulation Thickness (fibreglass), mm**	**Insulation Thickness (closed cell phenolic), mm**	**Recovery Jacket**
1.	Glycol Heating Piping	All sizes	40	25	Canvas
2.	Glycol Heating Piping Exposed to Outdoors	All sizes	50	32	Al
3.	Hot Water Heating Piping	All sizes	40	25	Canvas
4.	Vents within 3 m of Roof Outlet, as measured along pipe	All sizes	25	12	Canvas
5.	Air Separators		25	N/A	Aluminum
6.	Condensate Piping Exposed to Outdoors	All sizes	50	32	Al

END OF SECTION

1. GENERAL

1.1 General

.1 This Section describes the commissioning of the mechanical system.

.2 The commissioning of the mechanical system shall be in accordance with the Code of Practice for Commissioning Mechanical Systems in Buildings and as described in this Section.

.3 The commissioning process shall be applied to all products, equipment and systems provided under this Division.

.4 Work specified in this Section shall be performed by the Commissioning Agent, who shall be a qualified individual(s) hired by the Contractor.

1.2 Scope

.1 Demonstration of equipment and systems operations.

.2 Document all commissioning on commissioning sheets.

.3 Instruction seminars for the City's personnel.

1.3 Quality Assurance

.1 Work specified shall be performed by a qualified individual(s) or Commissioning Agency specialising in this type of Work.

2. COMMISSIONING PROCESS

2.1 Duties of the Commissioning Agent

.1 The Commissioning Agent shall plan, organise and implement the commissioning process and shall within one month of the award of the contract submit the name and address of the Contract Administrator.

.2 The Commissioning Agent shall provide a complete description of the systems operation, performance and flow data to the Contract Administrator for review.

.3 The Commissioning Agent shall prepare the commissioning plan and provide demonstration and instructions to the City’s staff over a period of time to enable the staff to become familiar with the systems.

2.2 Commissioning Schedule

.1 Within one (1) month of commencing with the project Work the Commissioning Agent shall review design intent and intended commissioning procedures with the Contract Administrator. One (1) month prior to the date of scheduled Substantial Performance, submit a detailed plan identifying the orderly progression of the pre-start commissioning check and

subsequent commissioning performance check of each sub-system, leading up to the ultimate commissioning of entire systems.

.2 Submit a schedule for the commissioning phase of the Work. This schedule shall show:

.1 Completion dates for each trade in each major section of the building.

.2 Timing of the various phases of the commissioning, testing, balancing and demonstration process.

.3 Submission dates for the various documents required prior to verification of commissioning by the Contract Administrator.

.4 Prepare a commissioning statement in which each of the four (4) phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

Phase 1 - System Readiness.

Phase 2 - System Start-up, Testing, Balancing, Etc.

Phase 3 - Verification of System Commissioning.

Phase 4 - Demonstration and Instruction.

.3 With the commissioning schedule noted above, submit a copy of all commissioning worksheets to be used during the commissioning process.

.4 Each phase is applicable to each major and separate system making up the work in Division 23 including controls and Division 26 interface as applicable.

2.3 Commissioning Phases

.1 **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

.1 Copies of all test and certificates have been submitted to the Contract Administrator.

.2 All safety controls installed and fully operational (dry run test).

.3 Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.

.4 Equipment lubrication and pre-start checks are complete.

.5 Air system cleaning complete.

.6 All DX systems checked for pressure and leakage.

.7 Filter systems installed and sealed in place (except for air system charcoal filters).

.8 Adjusting vibration isolation completed.

.9 Alignment of drives (direct and belt) completed.

.10 Control functional checks, including all alarms performed.

.11 Start-up verification checks by manufacturers representatives completed.

.12 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase, Phase 2.

.2 **Phase 2** - System Commissioning shall include but not necessarily be limited to:

.1 Activation of all systems.

.2 Testing and adjustment of all systems.

.3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the Commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.

.4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:

.1 Position all balance dampers in ductwork.

.2 Position all balance valves in piping systems (where appropriate).

.3 Make provisions for testing air pressures and flow rates.

.4 Set up air diffusers, registers and grilles.

.5 Set up all automatic temperature control devices.

.6 Set up constant volume and variable volume fans.

.7 Plug all air pressure and flow measuring holes.

.8 Adjust vibration isolators as necessary.

.9 Verification by the air balance contractor that all fire dampers have been checked.

.10 Air and water balance complete.

.5 Fine Tuning:

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Correction of problems revealed by Balancing Agency and change of fan speed and pitch as necessary.

.6 Testing:

.1 The Contract Administrator shall perform a detailed check of the following:

.1 All items and functions to be later demonstrated to the City's Representatives.

.2 Systems operation in the fire mode (pressurisation and smoke removal) in the presence of the authorities having jurisdiction. Obtain a written statement/ certificate of approval from the authorised manual jurisdiction.

.3 **Phase 3** - Verification of Commissioning.

.1 Verification of commissioning by the Contract Administrator shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 Location of and opening and closing of all access panels.

.2 Operation of all automatic control dampers and automatic temperature/volume adjustment controls.

.3 Proper response of all variable air volume valves to thermostats and volume adjustment controls.

.4 Operability of randomly selected fire dampers.

.5 Operation of all equipment and systems, under each mode of operation, including:

.6 BMS control features;

.7 Automatic controls;

.8 Boilers;

.9 Make-up air systems;

.10 Exhaust fans;

.11 Pumps;

.12 Coils;

.13 Tanks-expansion & glycol fill.

.2 At the completion of Phase 3, the Contractor shall submit the following to the Contract Administrator:

.1 A letter certifying that all Work specified under this Contract is complete, clean and operational in accordance with the Specification and Drawings.

.2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Contract Administrator.

.3 Record Drawings as specified.

.4 A letter from the testing and balancing agency certifying that all necessary data for inclusion in operating and maintenance manuals has been received.

.5 A statement confirming completion of BMS acceptance test, Section 23 09 33.

.3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Contract Administrator will provide a Certificate of Verification for Phase 3.

.4 Substantial Performance may, thereupon, be declared.

.4 **Phase 4** - Demonstration and Acceptance shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Contract Administrator and City upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

The following systems are to be commissioned:

3.1 HVAC Systems

.1 Boilers - check out by Manufacturer's Representative, gas and water piping connections, burner and controls, flue connections, boil out, chemical treatment, capacity tests, expansion tank pressures and capacity.

.2 Pumps - alignment, rotation, motor current draw, piping connections, flow and pressure test.

.3 Piping System - pressure tests, insulation, identification, water balance, hangers, expansion.

.4 Duct System - pressure tests, insulation, identification, air balance identification.

.5 Exhaust Fans - installation, rotation, motor current draw, accessories dampers, etc., air balance, identification.

.6 Variable Frequency Drives - installation, controls, speed modulation, connection to BMS.

.7 Control Valves - installation, controls, capacity modulation, connection to BMS, identification.

.8 Control Dampers - installation, operation, identification, capacity modulation, connection to BMS.

.9 Controls - See Section 23 09 33 - commissioning of controls by Controls Contractor under the supervision of the Contract Administrator.

3.2 General

.1 Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required Manufacturer's Representatives are in attendance.

3.3 Demonstrations

.1 Provide three (3) working days for demonstration of equipment to the City.

.2 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

.3 Demonstrate the following systems, in the form of instruction seminars and Contractor guided tour of the facility.

.1 Hydronic Heating Systems;

.2 Hydronic Cooling Systems;

.3 Air Systems;

.4 Control Systems;

.5 Chemical Treatment Systems;

.4 Demonstrate the following pieces of equipment:

.1 Boilers;

.2 Make-up Air Unit;

.3 Pumps;

.4 Heat Exchangers.

.5 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Contract Administrator one month prior to demonstration.

.6 Answer all questions raised by the City at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Provide for cleaning and degreasing of hot water heating, glycol, and condensate systems.

.2 Provide all necessary equipment and chemicals to treat hot water heating, glycol and condensate, system.

.3 Provide for flushing and disinfection of domestic water systems.

1.2 References

.1 American Society for Testing and Materials

.1 ASTM E 202, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 Waste Management and Disposal

.1 Dispose of unused cleaning solutions at official hazardous material collections site approved by the Contract Administrator.

.2 Do not dispose of unused cleaning solutions into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

.3 Remove from Site and dispose of packaging materials at appropriate recycling facilities.

.4 Dispose of corrugated cardboard, polystyrene and plastic packaging material in appropriate on-site bin for recycling in accordance with Site waste management program.

1.4 Quality Assurance

.1 Provide services of a chemical treatment agency to perform the cleaning and degreasing operation on-site and submit written reports on all situations found, actions taken and final results.

.1 Acceptable Agency: Betz Dearborn, Pace Chemicals Ltd., IPAC Chemicals Ltd.

.2 Inform the Contract Administrator and Commissioning Agent fifteen (15) working days prior to commencing of Work.

.3 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, Contractor and Commissioning Agent.

.4 Chemical treatment agency shall provide direction and assistance in the degreasing, cleaning and chemical treatment of all piping systems.

.5 Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilized for the duration of the cleaning process. Permanent equipment shall be flushed, degreased and chemically treated independent of the piping systems.

1.5 Submittals

.1 Submit Shop Drawings with complete description of proposed chemicals, quantities, calculations, procedures, test kits and equipment to be supplied. Along with product Shop Drawings, provide copies of data sheets, procedure instructions and analysis reports to be used on this Project.

.2 Include with the Shop Drawings Material Safety Data Sheets (MSDS) for all chemicals to be used.

.3 Provide written reports to the mechanical contractor and Contract Administrator containing procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.

.4 Submit written reports to the mechanical contractor and Contract Administrator containing results of tests taken every seven (7) days after completion of chemical treatment. Reports shall be done every seven (7) days for a minimum time period of thirty five (35) days.

.5 Provide monthly Site visits (12 minimum) within the warranty year to check the treatment, take samples, analyse and recommend proper addition of treatment. Provide written reports to the City after each visit with a copy to the Contract Administrator.

2. PRODUCTS

2.1 Materials

.1 Provide sufficient chemicals to treat and test the systems from the time of activation and acceptance of the building for the first year of operation by the City.

.2 Materials which may contact finished areas shall be colourless and non-staining. Chemicals used must comply with environmental and health standards applicable to the usage on this project.

.3 System Cleaner: Alkaline compound which in solution removes grease and petroleum products.

.4 Close System Treatment: Sequestering agent to reduce deposits and adjust pH, and a corrosion inhibitor.

2.2 Equipment

.1 Solution Pumps: Provide positive displacement diaphragm type metering pumps for adding chemicals. Pumps shall have an adjustable flow rate and be suitable for chemicals to be pumped. Pumps shall be self flushing. Provide pumps with plastic solution tanks complete with agitator, pump mounting, cover, provision for fill line and pump strainer. Size the pumps and tanks to permit operation for three (3) days at 50% pump capacity without refill of tanks. Provide agitator motor with terminals and junction box for electric wiring.

.2 Provide chemical pot feeder with a minimum of 10 L (2.6 USgal) capacity, semi-sphere top and bottom, one pot feeder per system, located as shown on system schematics and floor plans. If location is in question obtain clarification from the Contract Administrator prior to installation.

2.3 Test Kits

.1 Provide test kits as required to determine proper system treatment consisting of, but not limited to the following:

.1 Heating water test kit to determine proper treatment.

.2 Glycol systems treatment test kits to determine proper concentration and glycol inhibitor, this shall include a hydrometer type tester.

.2 Provide test kits for hardness and chlorides in addition to those listed above.

.3 Provide an electronic pH meter complete with three different calibration standard solutions.

.4 All test kits shall be provided with adequate chemicals and reagents for one (1) year of testing.

3. EXECUTION

3.1 Cleaning Hydronic Systems

.1 Timing

.1 Systems to be operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

3.2 System Cleaning

.1 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.2 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations to be used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of Work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water to be used to ensure water will not damage systems or equipment.

.3 Conditions at time of cleaning of systems

.1 Systems to be free from construction debris, dirt and other foreign material.

.2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers to be clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.4 Report on Completion of Cleaning

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.5 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water meter to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60° C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches so as to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to 82°C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38°C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.6 Glycol Systems:

.1 In addition to procedures specified above perform procedures specified herein.

.2 Test to prove concentration will prevent freezing to minus 40°C Test inhibitor strength and include in procedural report. Refer to ASTM E 202.

3.3 Start-up of Hydronic Systems

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems as specified in Section 23 08 00 - Commissioning of Mechanical.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure over a 48 hour period.

.11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.12 Adjust pipe supports, hangers, and springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, and repeat start-up procedures.

.15 Re-tighten bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.16 Check operation of drain valves.

.17 Adjust valve stem packings as systems settle down.

.18 Fully open all balancing valves (except those that are factory-set).

.19 Check operation of over-temperature protection devices on circulating pumps.

.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Complete and fully operational system of automatic controls, including all materials and labour.

.2 Submissions of technical system data.

.3 Demonstration of proposed installed controls system**.**

1.2 Work by Other Trades

.1 Division 26 shall provide 120V power for Controls Panels, SCU's and Central Computer Equipment.

.2 Division 23 shall install thermal wells, control valves and devices on piping, furnished by the HVAC controls contractor.

1.3 Renovation or Addition Projects

.1 Control Work involves renovations to an existing control system. The Contractor shall inspect the systems prior to Bid Opportunity close and include in the submission all interlocks and relays required to provide a fully operational controls system.

.2 The Contractor shall ensure that the installation and commissioning of the automation system shall not disrupt the use of the facilities.

.3 Prior to close of Bid Opportunity the Contractor shall inspect the system and include for replacement of defective control equipment and components.

1.4 Quality Assurance

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, and latest CSA Electrical Bulletins.

.2 The equipment manufacturer shall have trained service representatives resident in the Province where project is located.

.3 The following components shall be stocked locally:

.1 *Replacement SCU and internal components

.2 *Replacement IP's

.3 *Replacement Sensors and Actuators

1.5 Submittals

.1 Provide Shop Drawings including complete operating data, system drawings, wiring diagrams and written detailed operational description of sequences and engineering data on each control system component. Include sizing and arrangements as requested.

.2 Submit approved Shop Drawings for inclusion in operating and maintenance manuals.

1.6 City Orientation

.1 Contractor to provide three (3) weeks written notice to the Contract Administrator and the City prior to commencing formal training sessions.

.2 Formal training sessions shall commence only after "As-Built" Drawings have been completed, reviewed and approved by the Contract Administrator and shall be in addition to 15010 requirements.

.3 Provide for operator training according to the following schedule.

.1 A seminar/workshop covering all aspects of system use as follows:

.1 operation of hardware components

.2 system software configuration

.3 user/system interaction

.4 calibration of sensors and system

.5 trouble shooting of system and components

.6 preventative maintenance

.2 A review workshop at one (1) month after system acceptance.

.3 A seminar after six (6) months of operation for clarification of system operating techniques for building operators.

.4 Allow for additional one day training seminars in addition to the above seminars, within the first year of operation. These seminars are to be scheduled at City selected dates and times.

.5 Coordinate above seminars/workshops to occur during peak cooling and heating season as well as during one shoulder season.

.6 Provide three (3) complete sets of training manuals to the City prior to commencing of the training session, plus one manual to the Contract Administrator.

1.7 Warranty

.1 The Contractor shall supply and install at no cost all system software and hardware updates and upgrades occurring prior to the expiration of the warranty period.

1.8 System Activation

.1 Submit control calibration check sheet prior to system acceptance. Check sheets to include unit identification, controller/transmitter tag numbers, device controlled, controller PID settings, interlock devices and wire tag numbers.

.2 Set damper linkages, static pressure/volume controls as required by the Balancing Trade.

.3 Adjust and calibrate all room thermostats thirty (30) days prior to system acceptance.

1.9 Acceptance Testing

.1 A final operational acceptance test of seven (7) consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.

.2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialised control programs and algorithms, diagnostics and all other software.

.3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.

.4 After successful completion of the acceptance test, the Contract Administrator will issue written acceptance of the control system.

.5 Prior to acceptance of the Work, submit hard copy and electronic copy on diskette of final data base listings.

1.10 Costs

.1 All costs incurred in testing the controls system, including City and Contract Administrator demonstration cost shall be included for under this Contract. No additional charges will be entertained by the City.

.2 All equipment, software, consumable items, personnel and facilities as required to reasonably execute the factory or Site acceptance tests, including any signal simulation equipment shall be made available under the terms of this contract at no further cost to the City.

2. PRODUCTS

2.1 Electric and Electronic Control Systems for HVAC

.1 Refer to Section 23 09 33 - Electric and Electronic Control Systems for HVAC.

2.2 Control Panels

.1 Provide control panel of unitised cabinet type construction. Mount relays, switches and control point adjustment in cabinet and pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face

.2 Fabricate panels from 2.5 mm (12 ga) rolled sheet metal sheet with baked enamel finish, flush fitting, gasketted doors hung on piano type hinges and three point latches and locking handles. CSA approved for line voltage applications.

.3 Mount panels on vibration free wall or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

.4 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.

.5 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 VAC supply.

.6 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

.7 Identify all wiring by means of stamped markings on heat shrinkable tubing. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum twenty five (25) conductors to each wire bundle.

.8 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.

.9 Install "Hand-Off-Auto" selector switches such that safety controls and electrical over current protection are not overridden when selector switch is in the "Hand" position.

2.3 Wire

.1 Control wiring for digital functions shall be 18 AWG minimum with 300 Volt insulation.

.2 Control wiring for analog functions shall be 18 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

.3 Sensor wiring shall be 18 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

.4 Transformer current wiring shall be 16 AWG minimum.

2.4 Conduits and Cables

.1 All wiring shall be in conduit or trays. Conform to Division 26 requirements for conduit and tray specifications.

.2 Seal conduit where such conduit leaves heated areas and enters unheated area.

.3 Run low level signal lines in separate conduit from high level signal and power transmission lines.

.4 Identify each cable and wire at every termination point.

.5 Where applicable, mount field interface equipment (i.e. relays, transducers, etc.) in local device cabinets adjacent to field interface panels.

.6 Separate conduits shall be provided for pneumatic tubing and electrical wiring runs.

.7 Colour code all conductors and conduits by permanently applied colour bands on maximum 10 m intervals. Colour code shall follow base building schedule.

2.5 Related Accessories

.1 Provide and install all necessary transformers, transducers, interposing relays, interface devices, contactors, starters and EP's to perform control functions required.

3. EXECUTION

3.1 Installation

.1 Verify location of thermostats and other exposed control sensors with drawings before installation. Locate thermostats 1500 mm above floor.

.2 Install damper motors on outside of ducts. Do not locate in air stream, except for roof mounted equipment.

.3 Wire "hand/off/auto" selector switches such that automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.4 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.5 Install all safety limits at the operator’s level.

.6 Install pressure gauges on branch lines, at each controller, transmitter, and actuator excepting individual room thermostats.

END OF SECTION

1. GENERAL

1.1 General Intent and related information

.1 All Work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.

.2 The Work of this Division shall be scheduled, coordinated, and interfaced with the associated Work of other trades. Reference the Mechanical Division Sections for details.

.3 The Work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

.4 If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

.5 The City has a central monitoring system in place, and is currently monitoring building points at 457 Main St., Winnipeg, Manitoba (Confederation Building). These existing points are being monitored using the Johnson Controls N2 communications protocol DDC controllers, via the City supplied leased line modem network. Unless otherwise stated, these points shall remain as-is.

.6 Where new DDC points are identified in this Specification to be centrally monitored points, the controls contractor shall provide and install the required N2 protocol capable hardware and software to interface these points, and where required, extended the existing N2 trunk to any new DDC controllers. It is the controls contractors' responsibility to integrate any new DDC points into the City's existing Johnson Controls Metasys EA servers and workstations. These servers and workstations are located at 510 Main St. Winnipeg, MB.

1.2 Definitions

.1 Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.

.2 Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level.

.3 Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated work of other related trades.

.4 BMS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work.

.5 Control Sequence: A BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

.6 Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.

.7 BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

.8 Node: A digitally programmable entity existing on the BMS network.

.9 BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.

.10 PC: IBM-compatible Personal Computer from a recognized major manufacturer

.11 Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.

.12 Protocol: The term “protocol” and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.

.13 Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.

.14 The following abbreviations and acronyms may be used in describing the work of this Division:

ADC	-	Analog to Digital Converter
AI	-	Analog Input
AN	-	Application Node
AO	-	Analog Output
ASCII	-	American Standard Code for Information Interchange
AWG	-	American Wire Gauge
CPU	-	Central Processing Unit
CRT	-	Cathode Ray Tube
DAC	-	Digital to Analog Converter
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electronically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface

HOA	-	Hand-Off-Auto
ID	-	Identification
I/O	-	Input/Output
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open
OWS	-	Operator Workstation
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VAV	-	Variable Air Volume
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

1.3 BMS Description

.1 The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems in place at the City of Winnipeg. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the City's IT staff to ensure that the FMS will perform in the City's environment without disruption to any of the other activities taking place on that LAN.

.2 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

.3 Where necessary and as dictated elsewhere in these Specifications, the City of Winnipeg's existing ADS/ADX Server(s) shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions.

.4 The Work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division Specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

.5 The BMS Work shall consist of the provision of all labour, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

.6 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

.7 Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.

.8 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

.1 Operator information, alarm management and control functions.

.2 Enterprise-level information and control access.

.3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.

.4 Diagnostic monitoring and reporting of BMS functions.

.5 Offsite monitoring and management access.

.6 Energy management

.7 Standard applications for terminal HVAC systems.

1.4 Quality Assurance

.1 General

.1 The following companies are approved Controls Contractors:

.1 Johnson Controls Branch Office

1.5 References

.1 UL 864 UUKL Smoke Control

.2 UL 268 Smoke Detectors

.3 UL 916 Energy Management

.4 NFPA 70 - National Electrical Code

.5 NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems

.6 NFPA 92A and 92B Smoke Purge/Control Equipment

.7 (FCC) including Part 15, Radio Frequency Devices.

.8 ANSI/EIA 909.1-A-1999 (LonWorks)

.9 ANSI/ASHRAE Standard 195-2004 (BACnet)

.1 In the case of conflicts or discrepancies, the more stringent regulation shall apply.

.2 All Work shall meet the approval of the Authorities Having Jurisdiction at the Site.

1.6 Work by Others

.1 The demarcation of Work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the BMS RESPONSIBILITY MATRIX

BMS RESPONSIBILITY MATRIX				
Scope of Work	**Supply**	**Install**	**Low Volt. Wiring/Tube**	**Line Power**
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
BMS conduits and raceway	BMS	BMS	BMS	BMS
Automatic dampers	BMS	23	N/A	N/A
Manual valves	23	23	N/A	N/A
Automatic valves	BMS	23	BMS	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	BMS	23	BMS	BMS
BMS Current Switches.	BMS	BMS	BMS	N/A
BMS Control Relays	BMS	BMS	BMS	N/A
Power distribution system monitoring interfaces	26	26	BMS	26
BMS interface with Chiller controls	BMS	BMS	BMS	BMS
All BMS Nodes, equipment, housings, enclosures and panels.	BMS	BMS	BMS	BMS
Smoke Detectors	26	26	26	26
Fire/Smoke Dampers	23	23	BMS	26
Boiler wiring	23	23	23	23
Fire Alarm shutdown relay interlock wiring	26	26	26	26
Fire Alarm smoke control relay interlock wiring	26	26	26	26
Packaged RTU space mounted controls	23*	BMS	BMS	26
Packaged RTU factory-mounted controls	23*	23	BMS	26
Packaged RTU field-mounted controls	BMS	BMS	BMS	26
Starters, HOA switches	26	26	N/A	26

1.7 Submittals

.1 Shop Drawings, Product Data, and Samples

.1 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the City, and the Contract Administrator.

.2 At a minimum, submit the following:

.1 BMS network architecture diagrams including all nodes and interconnections.

.1 Systems schematics, sequences and flow diagrams.

.2 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.

.3 Samples of Graphic Display screen types and associated menus.

.4 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

.5 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type

.6 Details of all BMS interfaces and connections to the Work of other trades.

.7 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.8 Record Documentation

.1 Operation and Maintenance Manuals

.1 The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:

.1 Table of contents.

.2 As-built system record drawings. Computer Aided Drawings (CAD) Record Drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

.3 Manufacturers product data sheets or catalog pages for all products including software.

.4 System Operator’s manuals.

.5 Archive copy of all Site-specific databases and sequences.

.6 BMS network diagrams.

.7 Interfaces to all third-party products and work by other trades.

.2 The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

2. PRODUCTS

2.1 General Description

.1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other City provided networks.

.2 The Building Management System shall consist of the following:

.1 Standalone Network Automation Engine(s)

.2 Field Equipment Controller(s)

.3 Input/Output Module(s)

.4 Local Display Device(s)

.5 Network processing, data storage and communications equipment

.6 Other components required for a complete and working BMS

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

.4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.5 Acceptable Manufacturers

.1 Johnson Controls Metasys Extended Architecture

2.2 BMS Architecture

.1 Automation Network

.1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

.2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

.3 The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

.4 Network Automation Engines (NAE) shall reside on the automation network.

.5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.6 The City shall provide all private and public telephones lines, ISDN lines and Internet Service Provider services and connections as necessary for the Controls Contractor to complete the work as contracted at the City's direct cost. The Controls Contractor shall identify the specific requirements in their shop drawing submittal.

.2 Control Network

.1 Network Automation Engines shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

.1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.

.2 LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).

.3 The Johnson Controls N2 Field Bus.

.2 Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

.3 DDC Controllers shall reside on the control network.

.4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, or Johnson Controls N2 Field Bus.

.5 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.3 Integration (if required)

.1 Hardwired

.1 Analog and digital signal values shall be passed from one system to another via hardwired connections.

.2 There will be one separate physical point on each system for each point to be integrated between the systems.

.2 Direct Protocol (Integrator Panel)

.1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas.

.2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.

.3 Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

.3 BACnet Protocol Integration - BACnet

.1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.

.2 A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

.3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.3 User Interface

.1 Dedicated Web Based User Interface

.1 Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.

.2 Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.

.1 Microsoft Internet Explorer for user interface functions

.2 Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions

.3 Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports

.4 Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

.3 PC Hardware – The personal computer(s) shall be configured as follows:

.1 Memory – 1 GB (512 MB Minimum)

.2 CPU– Pentium 4 processor. 2.8 Hz Clock Speed (2.0 GHz minimum)

.3 Hard Drive – 80 GB free hard drive space (40GB minimum)

.4 Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department

.5 CD ROM Drive – 32X performance

.6 Ports – (2) Serial and (1) parallel, (2) USB ports

.7 Keyboard – 101 Keyboard and 2 Button Mouse

.8 CRT configuration – 1-2 CRTs as follows:

.1 Each Display – 17" Flat Panel Monitor 1280 x 1024 resolution minimum.

.2 16 bit or higher color resolution

.3 Display card with multiple monitor support

.9 LAN communications – Ethernet communications board; 3Comm or equal in accordance with B6.

.4 Operating System Software

.1 Windows XP Professional

.2 Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.

.3 Provide software registration cards to the City for all included software.

.5 Peripheral Hardware

.1 Reports printer:

.1 Printer Make – Hewlett Packard DeskJet

.2 Print Speed – 600 DPI Black, 300 DPI Color

.3 Buffer – 64 K Input Print Buffer

.4 Color Printing – Include Color Kit

.2 Distributed Web Based User Interface

.1 All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

.2 The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.

.3 Minimum hardware requirements:

.1 256 MB RAM

.2 2.0 GHz Clock Speed Pentium 4 Microprocessor

.3 40.0 GB Hard Drive

.4 1 Keyboard with 83 keys (minimum)

.5 SVGA 1024x768 resolution display with 64K colors and 16 bit color depth

.6 Mouse or other pointing device

.3 User Interface Application Components

.1 Operator Interface

.1 An integrated browser based client application shall be used as the user operator interface program.

.2 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

.3 The user interface software shall provide help menus and instructions for each operation and/or application.

.4 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

.5 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

.1 User access for selective information retrieval and control command execution

.2 Monitoring and reporting

.3 Alarm, non-normal, and return to normal condition annunciation

.4 Selective operator override and other control actions

.5 Information archiving, manipulation, formatting, display and reporting

.6 FMS internal performance supervision and diagnostics

.7 On-line access to user HELP menus

.8 On-line access to current FMS as-built records and documentation

.9 Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.

.10 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

.2 Navigation Trees

.1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

.2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

.3 The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

.3 Alarms

.1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

.1 Log date and time of alarm occurrence.

.2 Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.

.3 Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

.4 Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.

.5 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

.6 Any attribute of any object in the system may be designated to report an alarm.

.2 The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions

.3 The FMS shall annunciate application alarms at minimum, as required by Part 3.

.4 Reports and Summaries

.1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

.1 All points in the BMS

.2 All points in each BMS application

.3 All points in a specific controller

.4 All points in a user-defined group of points

.5 All points currently in alarm

.6 All points locked out

.7 All BMS schedules

.8 All user defined and adjustable variables, schedules, interlocks and the like.

.9 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

.10 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

.11 The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

.5 Schedules

.1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

.1 Weekly schedules

.2 Exception Schedules

.3 Monthly calendars

.2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

.3 It shall be possible to define one or more exception schedules for each schedule including references to calendars

.4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

.5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.

.6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.

.7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

.6 Password

.1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.

.2 Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.

.3 The system shall allow each user to change his or her password at will.

.4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

.5 A minimum of five levels of access shall be supported individually or in any combination as follows:

.1 Level 1 = View Data

.2 Level 2 = Command

.3 Level 3 = Operator Overrides

.4 Level 4 = Database Modification

.5 Level 5 = Database Configuration

.6 Level 6 = All privileges, including Password Add/Modify

.6 A minimum of 100 unique passwords shall be supported.

.7 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

.8 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

.7 Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

.8 Dynamic Color Graphics

.1 The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

.2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.

.3 The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.

.4 Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:

.1 All graphics shall be fully scalable

.2 The graphics shall support a maintained aspect ratio.

.3 Multiple fonts shall be supported.

.4 Unique background shall be assignable on a per graphic basis.

.5 The color of all animations and values on displays shall indicate if the status of the object attribute.

.5 Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device

.6 Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

.1 The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.

.2 In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

.7 Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

.9 Historical trending and data collection

.1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

.1 Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

.1 Defined time interval

.2 Upon a change of value

.2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

.10 Trend data viewing and analysis

.1 Provide a trend viewing utility that shall have access to all database points.

.2 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.

.3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends

.4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.

.5 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.

.6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

.7 Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.4 Network Automation Engines (NAE)

.1 Network Automation Engine (**NAE**)

.1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

.2 Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.

.3 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

.1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

.2 The NAE shall support up four (4) concurrent users.

.3 The web based user shall have the capability to access all system data through one NAE.

.4 Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

.5 Systems that require the user to address more than one NAE to access all system information are not acceptable.

.6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

.7 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

.8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

.1 Configuration

.2 Commissioning

.3 Data Archiving

.4 Monitoring

.5 Commanding

.6 System Diagnostics

.9 Systems that require workstation software or modified web browsers are not acceptable.

.10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

.4 Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

.5 Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

.6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.

.7 The NAE shall include troubleshooting LED indicators to identify the following conditions:

.1 Power - On/Off

.2 Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic

.3 Ethernet Connection Speed – 10 Mbps/100 Mbps

.4 FC Bus – Normal Communications/No Field Communications

.5 Peer Communication – Data Traffic Between NAE Devices

.6 Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running

.7 Bat Fault – Battery Defective, Data Protection Battery Not Installed

.8 Fault – General Fault

.9 Modem RX – NAE Modem Receiving Data

.10 Modem TX – NAE Modem Transmitting Data

.8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

.1 Up to two (2) USB port

.2 Up to two (2) URS-232 serial data communication port

.3 Up to two (2) RS-485 port

.4 One (1) Ethernet port

.9 Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

.10 Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

.1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

.2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

.11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).

.12 Controller network – The NAE shall support the following communication protocols on the controller network:

.1 The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.1 The Conformance Statements shall be submitted 10 day prior to bidding.

.2 The NAE shall support a minimum of 100 control devices.

.3 The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.

.2 All LonWorks controls devices shall be LonMark certified.

.3 The NAE shall support a minimum of 255 LonWorks enabled control devices.

.2 The NAE shall support the Johnson Controls N2 Field Bus.

.1 The NAE shall support a minimum of 100 N2 control devices.

.2 The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.

.3 The Bus shall employ a master/slave protocol where the NAE is the master.

.4 The Bus shall employ a four (4) level priority system for polling frequency.

.5 The Bus shall be optically isolated from the NAE.

.6 The Bus shall support the Metasys Integrator System.

2.5 DDC System Controllers

.1 Field Equipment Controller (**FEC**)

.1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

.2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

.3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

.4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.5 The FEC shall include a removable base to allow pre-wiring without the controller.

.6 The FEC shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Start-up in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Field Controller Bus - Normal Data Transmission

.7 Field Controller Bus - No Data Transmission

.8 Field Controller Bus - No Communication

.9 Sensor-Actuator Bus - Normal Data Transmission

.10 Sensor-Actuator Bus - No Data Transmission

.11 Sensor-Actuator Bus - No Communication

.7 The FEC shall accommodate the direct wiring of analog and binary I/O field points.

.8 The FEC shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, current Mode

.4 Binary Outputs - shall output the following:

.1 24 VAC Triac

.5 Configurable Outputs - shall be capable of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output Mode

.9 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).

.1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The FC Bus shall support communications between the FECs and the NAE.

.3 The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.

.4 The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.

.5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

.10 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

.1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The SA Bus shall support a minimum of 10 devices per trunk.

.3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.

.11 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

.12 The FEC shall support, but not be limited to, the following:

.1 Hot water, chilled water/central plant applications

.2 Built-up air handling units for special applications

2.6 Terminal units

.1 Special programs as required for systems control

2.7 Field Devices

.1 Input/Output Module **(IOM)**

.1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.

.2 The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

.3 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.4 The IOM shall have a minimum of 4 points to a maximum of 17 points.

.5 The IOM shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, current Mode

.4 Binary Outputs - shall output the following:

.1 24 VAC Triac

.5 Configurable Outputs - shall be capable of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output Mode

.6 The IOM shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Normal Data Transmission

.7 No Data Transmission

.8 No Communication

2.8 Networked Thermostat (TEC)

.1 The Networked Thermostats shall be capable of controlling the following:

.1 A four pipe fan coil system with multi-speed fan control.

.2 A pressure dependant Variable Air Volume System or similar zoning type system using reheat.

.3 A two pipe fan coil with a single speed fan.

.2 The Networked Thermostat shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135, Clause 9.

.1 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.

.3 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.

.1 Two line, 8 character backlit display

.2 LED indicators for Fan, Heat, and Cool status

.3 Five (5) User Interface Keys

.1 Mode

.2 Fan

.3 Override

.4 Degrees C/F

.5 Up/Down

.4 The display shall continuously scroll through the following parameters:

.1 Room Temperature

.2 System Mode

.3 Schedule Status – Occupied/Unoccupied/Override

.4 Applicable Alarms

.5 The Networked Thermostats shall provide the flexibility to support the following inputs:

.1 Integral Indoor Air Temperature Sensor

.2 Duct Mount Air Temperature Sensor

.3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.

.4 Two configurable binary inputs

.6 The Networked Thermostats shall provide the flexibility to support the following outputs:

.1 Three Speed Fan Control

.2 On/Off Control

.3 Floating Control

.4 Proportional (0 to 10V) Control

.7 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.

.8 The Networked Thermostat shall provide the flexibility to adjust the following parameters:

.1 Adjustable Temporary Occupancy from 0 to 24 hours

.2 Adjustable heating/cooling deadband from 2º F to 5º F

.3 Adjustable heating/cooling cycles per hour from 4 to 8

.9 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

2.9 Network Sensors (NS)

.1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

.1 Zone Temperature

.2 Zone humidity

.3 Zone setpoint

.2 The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.

.3 The Network Sensors shall include the following items:

.1 A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.

.2 An LED to indicate the status of the Override feature.

.3 A button to toggle the temperature display between Fahrenheit and Celsius.

.4 A button to initiate a timed override command

.4 The NS shall be available with either screw terminals or phone jack.

.5 The NS shall be available in either surface mount or wall mount styles.

2.10 Many-To-One Wireless Room Temperature Sensor System (WRS)

.1 The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).

.1 The WRS Receiver shall use direct sequence spread spectrum RF technology.

.2 The WRS Receiver shall operate on the 2.4 GHZ ISM Band.

.3 The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.

.6 The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.

.7 The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

.8 The WRS Receiver shall have LED indicators to provide information regarding the following conditions:

.1 Power On/Off

.2 Ethernet – Receiver Activity/No Activity

.3 Wireless Normal Mode – Transmission from sensors/No Transmission

.4 Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal

.5 Ethernet Connection – No connection/10Mbps connection/100Mbps connection

.6 Network Activity – No Network Activity/Half-Duplex Communication/Full-Duplex Communication

.2 The WRS Sensors shall sense and report room temperatures to the WRS Receiver.

.1 The WRS Sensors shall use direct sequence spread spectrum RF technology.

.2 The WRS Sensors shall operate on the 2.4 GHZ ISM Band.

.3 The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The WRS sensors shall be available with

.1 Warmer/Cooler Set Point Adjustment

.2 No Set Point Adjustment

.3 Set Point Adjustment Scale – 55 to 85º F.

.4 The WRS sensors shall be assembled in NEMA 1 plastic housings.

2.11 System Tools

.1 System Configuration Tool **(SCT)**

.1 The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NIE).

.2 The configuration tool shall provide an archive database for the configuration and application data.

.3 The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.

.4 The configuration tool shall include the following features:

.1 Basic system navigation tree for connected networks

.2 Integration of Metasys N1, LonWorks, and BACnet enabled devices

.3 Customized user navigation trees

.4 Point naming operating parameter setting

.5 Graphic diagram configuration

.6 Alarm and event message routing

.7 Graphical logic connector tool for custom programming

.8 Downloading, uploading, and archiving databases

.5 The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:

.1 BACnet Devices

.2 LonWorks devices

.3 N2 Bus devices

.4 Metasys N1 networks

.6 The configuration tool shall be capable of programming the Field Equipment Controllers.

.1 The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.

.2 The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.

.3 The configuration tool shall contain a library of standard applications to be used for configuration.

.7 The configuration tool shall be capable of programming the field devices.

.1 The configuration tool shall provide the capability to configure, simulate, and commission the field devices.

.2 The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.

.3 The configuration tool shall contain a library of standard applications to be used for configuration

.8 A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.

.1 The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).

.2 The wireless use of configuration tool shall be the same as a wired connection in every respect.

.3 The wireless connection shall use the Bluetooth Wireless Technology.

.9 Wireless MS/TP Converter (BTCVT)

.1 The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.

.2 The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.

.3 The converter shall employ Bluetooth Wireless Technology.

.4 The converter shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.

.5 The converter shall operate over a minimum of thirty three (33) feet within a building.

.6 The converter shall have LED indicators to provide information regarding the following conditions:

.1 Power - On/Off

.2 Fault – Fault/No Fault

.3 SA/FC Bus – Bus Activity/ No Bus Activity

.4 Blue – Bluetooth Communication Established/ Bluetooth Communication Not Established

.5 The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.

2.12 Input Devices

.1 General Requirements

.1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

.2 Temperature Sensors

.1 General Requirements:

.1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

.2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

.3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Chilled Water	$\pm$ .5°F.
Room Temp	$\pm$ .5°F.

Point Type	Accuracy
Duct Temperature	± .5°F.
All Others	± .75°F.

.2 Room Temperature Sensors

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have the following options when specified:

.1 Setpoint reset slide switch providing a ±3 degree (adjustable) range.

.2 Individual heating/cooling setpoint slide switches.

.3 A momentary override request push button for activation of after-hours operation.

.4 Analog thermometer.

.3 Room Temperature Sensors with Integral Display

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:

.1 Display room and outside air temperatures.

.2 Display and adjust room comfort setpoint.

.3 Display and adjust fan operation status.

.4 Timed override request push button with LED status for activation of after-hours operation.

.5 Display controller mode.

.6 Password selectable adjustment of setpoint and override modes.

.4 Thermo wells

.1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.

.2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.

.3 Thermo wells and sensors shall be mounted in a threadolet or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.

.4 Thermo wells shall be constructed of 316 stainless steel.

.5 Outside Air Sensors

.1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

.2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

.3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

.6 Duct Mount Sensors

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

.7 Averaging Sensors

.1 For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

.2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

.3 Capillary supports at the sides of the duct shall be provided to support the sensing string.

.8 Acceptable Manufacturers: Johnson Controls, Setra.

2.13 Humidity Sensors

.1 The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.

.2 The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

.3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

.4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

.5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

.6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

.7 Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.

2.14 Differential Pressure Transmitters

.1 General Air and Water Pressure Transmitter Requirements:

.1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

.2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

.3 Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and City permanent, easy-to-use connection.

.4 A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

.2 Low Differential Water Pressure Applications (0” - 20” w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

.1 .01-20” w.c. input differential pressure range.

.2 4-20 mA output.

.3 Maintain accuracy up to 20 to 1 ratio turndown.

.4 Reference Accuracy: +0.2% of full span.

.3 Acceptable Manufacturers: Setra and Mamac.

.1 Medium to High Differential Water Pressure Applications (Over 21” w.c.)

.1 The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:

.1 Differential pressure range 10” w.c. to 300 PSI.

.2 Reference Accuracy: ±1% of full span (includes non-linearity, hysteresis, and repeatability).

.2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

.3 Acceptable Manufacturers: Setra and Mamac.

.2 Building Differential Air Pressure Applications (-1” to +1” w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

.1 -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)

.2 4-20 mA output.

.3 Maintain accuracy up to 20 to 1 ratio turndown.

.4 Reference Accuracy: +0.2% of full span.

.3 Acceptable Manufacturers: Johnson Controls and Setra.

.3 Low Differential Air Pressure Applications (0” to 5” w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

.1 (0.00 - 1.00” to 5.00”) w.c. input differential pressure ranges. (Select range appropriate for system application.)

.2 4-20 mA output.

.3 Maintain accuracy up to 20 to 1 ratio turndown.

.4 Reference Accuracy: +0.2% of full span.

.3 Acceptable Manufacturers: Johnson Controls and Setra.

.4 Medium Differential Air Pressure Applications (5" to 21" w.c.)

.1 The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:

.1 Zero & 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. (to 100 PSIG.

.3 Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).

.2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

.3 Acceptable manufacturers: Johnson Controls and Setra.

.4 Flow Monitoring

.1 Air Flow Monitoring

.1 Fan Inlet Air Flow Measuring Stations

.1 At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.

.2 Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm$ 20° in the approaching air stream.

.3 The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.

.4 Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., Ebtron, or Dietrich Standard.

.2 Single Probe Air Flow Measuring Sensor

.1 The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.

.3 Duct Air Flow Measuring Stations

.1 Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

.2 Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

.3 The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.

.4 The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.

.5 The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.

.6 Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.

.7 Installation Considerations

.1 The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests, and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.

.2 The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

.3 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

.4 Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.

.5 Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

.8 Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard.

.4 Static Pressure Traverse Probe

.1 Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

.2 Acceptable manufacturers: Cleveland Controls

.5 Shielded Static Air Probe

.1 A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

.2 Water Flow Monitoring

.1 Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.

.2 Acceptable manufacturers: Onicon

.5 Power Monitoring Devices

.1 Current Measurement (Amps)

.1 Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

.2 Current Transformer – A split core current transformer shall be provided to monitor motor amps.

.1 Operating frequency – 50 - 400 Hz.

.2 Insulation – 0.6 Kv class 10Kv BIL.

.3 UL recognized.

.4 Five amp secondary.

.5 Select current ration as appropriate for application.

.6 Acceptable manufacturers: Veris Industries

.3 Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

.1 6X input over amp rating for AC inrushes of up to 120 amps.

.2 Manufactured to UL 1244.

.3 Accuracy: +.5%, Ripple +1%.

.4 Minimum load resistance 30kOhm.

.5 Input 0-20 Amps.

.6 Output 4-20 mA.

.7 Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

.8 Acceptable manufacturers: Veris Industries

.6 Smoke Detectors

.1 Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.

.7 Status and Safety Switches

.1 General Requirements

.1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Current Sensing Switches

.1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

.2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

.3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.4 Acceptable manufacturers: Veris Industries

.3 Air Filter Status Switches

.1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

.3 Provide appropriate scale range and differential adjustment for intended service.

.4 Acceptable manufacturers: Johnson Controls, Cleveland Controls

.4 Air Flow Switches

.1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

.2 Acceptable manufacturers: Johnson Controls, Cleveland Controls

.5 Air Pressure Safety Switches

.1 Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

.3 Acceptable manufacturers: Johnson Controls, Cleveland Controls

.6 Water Flow Switches

.1 Water flow switches shall be equal to the Johnson Controls P74.

.7 Low Temperature Limit Switches

.1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

.2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

.4 The low temperature limit switch shall be equal to Johnson Controls A70.

.3 Output Devices

.1 Actuators

.1 General Requirements

.1 Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.

.2 Electronic Damper Actuators

.1 Electronic damper actuators shall be direct shaft mount.

.2 Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.

.3 Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.4 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

.5 Acceptable manufacturers: Johnson Controls, Mamac.

.3 Electronic Valve Actuators

.1 Electronic valve actuators shall be manufactured by the valve manufacturer.

.2 Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.

.3 Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer’s recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

.4 Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.5 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

.6 Acceptable manufacturers: Johnson Controls

.4 Control Pilot Relays

.1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

.2 Mounting Bases shall be snap-mount.

.3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

.4 Contacts shall be rated for 10 amps at 120VAC.

.5 Relays shall have an integral indicator light and check button.

.6 Acceptable manufacturers: Johnson Controls, Lectro

.5 Lighting Control Relays

.1 Lighting control relays shall be latching with integral status contacts.

.2 Contacts shall be rated for 20 amps at 277 VAC.

.3 The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.

.4 Lighting control relays shall be controlled by:

.1 Pulsed Tri-state Output – Preferred method.

.2 Pulsed Paired Binary Outputs.

.3 A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the “dry-contact” type.

.5 The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

.2 Control Valves

.1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.

.2 Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving **variable** flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving **constant** flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.

.3 Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.

.4 Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.

.5 Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

.6 Acceptable manufacturers: Johnson Controls

.3 Electronic Signal Isolation Transducers

.1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.

.2 The signal isolation transducer shall provide ground plane isolation between systems.

.3 Signals shall provide optical isolation between systems.

.4 Acceptable manufacturers: Advanced Control Technologies

.4 External Manual Override Stations

.1 External manual override stations shall provide the following:

.1 An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.

.2 A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.

.3 A Status LED shall illuminate whenever the output is ON.

.4 An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.

.5 Contacts shall be rated for a minimum of 1 amp at 24 VAC.

.5 Electronic/Pneumatic Transducers

.1 Electronic to Pneumatic transducers shall provide:

.1 Output: 3-15 PSIG.

.2 Input: 4-20 mA or 0-10 VDC.

.3 Manual output adjustment.

.4 Pressure gauge.

.5 External replaceable supply air filter.

.6 Acceptable manufacturers: Johnson Controls, Mamac

.4 Miscellaneous Devices

.1 Variable Frequency Motor Speed Control Drives

.2 Local Control Panels

.1 All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

.2 In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

.3 All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

.4 Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

.5 All wiring shall be neatly installed in plastic trays or tie-wrapped.

.6 A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

.3 Power Supplies

.1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

.2 Input: 120 VAC +10%, 60Hz.

.3 Output: 24 VDC.

.4 Line Regulation: +0.05% for 10% line change.

.5 Load Regulation: +0.05% for 50% load change.

.6 Ripple and Noise: 1 mV rms, 5 mV peak to peak.

.7 An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

.8 A power disconnect switch shall be provided next to the power supply.

.4 Thermostats

.1 Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

3. EXECUTION

3.1 BMS Specific Requirements

.1 Graphic Displays

.1 Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.

.2 User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

.2 Custom Reports:

.1 Provide custom reports as required for this project:

.3 Actuation / Control Type

.1 Primary Equipment

.1 Controls shall be provided by equipment manufacturer as specified herein.

.2 All damper and valve actuation shall be electric.

.4 Air Handling Equipment

.1 All air handers shall be controlled with a HVAC-DDC Controller

.2 All damper and valve actuation shall be electric.

.5 Terminal Equipment:

.1 Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.

.2 All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2 Installation Practices

.1 BMS Wiring

.1 All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.

.2 All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.

.3 The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

.4 Class 2 Wiring

.1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.

.2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

.5 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

.6 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

.2 BMS Line Voltage Power Source

.1 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.

.2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.

.3 DDC terminal unit controllers may use AC power from motor power circuits.

.3 BMS Raceway

.1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".

.2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Contract Administrator.

.3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

.4 Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

.4 Penetrations

.1 Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

.2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

.3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

.4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square. .

.5 BMS Identification Standards

.1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

.1 Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

.6 BMS Panel Installation

.1 The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

.2 The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

.7 Input Devices

.1 All Input devices shall be installed per the manufacturer recommendation

.2 Locate components of the BMS in accessible local control panels wherever possible.

.8 HVAC Input Devices – General

.1 All Input devices shall be installed per the manufacturer recommendation

.2 Locate components of the BMS in accessible local control panels wherever possible.

.3 The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

.4 Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

.5 Outside Air Sensors

.1 Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.

.2 Sensors shall be installed with a rain proof, perforated cover.

.6 Water Differential Pressure Sensors

.1 Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.

.2 Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.

.3 The transmitters shall be installed in an accessible location wherever possible.

.7 Medium to High Differential Water Pressure Applications (Over 21” w.c.):

.1 Air bleed units, bypass valves and compression fittings shall be provided.

.8 Building Differential Air Pressure Applications (-1” to +1” w.c.):

.1 Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.

.2 The interior tip shall be inconspicuous and located as shown on the drawings.

.9 Air Flow Measuring Stations:

.1 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.

.2 Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

.10 Duct Temperature Sensors:

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

.2 The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.

.3 For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.

.4 The sensor shall be mounted to suitable supports using factory approved element holders.

.11 Space Sensors:

.1 Shall be mounted per ADA requirements.

.2 Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

.12 Low Temperature Limit Switches:

.1 Install on the discharge side of the first water or steam coil in the air stream.

.2 Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

.13 Air Differential Pressure Status Switches:

.1 Install with static pressure tips, tubing, fittings, and air filter.

.14 Water Differential Pressure Status Switches:

.1 Install with shut off valves for isolation.

.9 HVAC Output Devices

.1 All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.

.2 Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

.3 Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

.4 Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 34.5 kPa (5 PSI).

.5 Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.3 Training

.1 The BMS contractor shall provide the following training services:

.1 One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4 Commissioning

.1 Fully commission all aspects of the Building Management System work.

.2 Acceptance Check Sheet

.1 Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.

.2 Submit the check sheet to the Contract Administrator for approval

.3 The Contract Administrator will use the check sheet as the basis for acceptance with the BMS Contractor.

.3 Promptly rectify all listed deficiencies and submit to the Contract Administrator that this has been done.

3.5 Sequences

.1 Refer to Section 23 09 93 - Sequence of Operations for HVAC Controls.

3.6 Point Lists

.1 Refer to Section 23 09 33.13 - Controls Points List.

END OF SECTION

CONTROLS POINTS LIST

1. GENERAL

.1 A point is a specific software address which is resident in the SCU and which is identified with a particular field sensor, instrument or sensor.

.2 The point schedule contains a general list and description of the points to be connected. The Contractor shall examine the point schedule and ensure that all points required to make the described control sequences work are provided, whether included in the point schedule or not.

.3 The relationships between the points, systems and building are described in the control sequences, Section 23 09 93 - Sequence of Operations for HVAC Controls.

.4 Consult with the Contract Administrator during the Shop Drawing stage to finalise the physical terminal address of each point within the SCU.

.5 The provided points list is not meant to be an exhaustive complete list of all points in the mechanical system. The Contractor is responsible for providing all required points for a fully functioning system.

2. CONTROLS POINTS LIST

.1 The following is the required points list for the existing equipment. The intent is to gather information currently not available to operators.

Controls Points List For Existing Equipment				
Description	**Type**	**Value**	**Units**	**System**
B-1 LWCO Alarm	DI			Existing Mech. Room
B-2 LWCO Alarm	DI			Existing Mech. Room
Pump P-1 Failure Alarm	DI			Existing Mech. Room
Pump P-2 Failure Alarm	DI			Existing Mech. Room
Pump P-3 Failure Alarm	DI			Existing Mech. Room
Pump P-4 Failure Alarm	DI			Existing Mech. Room
Pump P-5 Failure Alarm	DI			Existing Mech. Room
Pump P-6 Failure Alarm	DI			Existing Mech. Room
Pump P-7 Failure Alarm	DI			Existing Mech. Room
Fluid Cooler temperature supply	AI		°C	Existing Mech. Room
Fluid Cooler temperature return	AI		°C	Existing Mech. Room
Building Loop temperature supply	AI		°C	Existing Mech. Room
Building Loop temperature return	AI		°C	Existing Mech. Room

CONTROLS POINTS LIST

.2 The following is the minimum required points list for the new equipment/systems.

Controls Points List For New Equipment				
Description	**Type**	**Value**	**Units**	**System**
B-3 Enable/disable	DO			Boiler Heating Loop
B-3 five stage modulating signal	AO			Boiler Heating Loop
B-3 status	DI			Boiler Heating Loop
B-3 general alarm from boiler control panel	DI			Boiler Heating Loop
B-3 flow switch	DI			Boiler Heating Loop
B-4 Enable/disable	DO			Boiler Heating Loop
B-4 five stage modulating signal	AO			Boiler Heating Loop
B-4 status	DI			Boiler Heating Loop
B-4 general alarm from boiler control panel	DI			Boiler Heating Loop
B-4 flow switch	DI			Boiler Heating Loop
Boiler disconnect switch alarm	DI			Boiler Heating Loop
P-8 Enable/disable	DO			High Temp. Loop
P-8 Status	DI			High Temp. Loop
P-8 Fault	DI			High Temp. Loop
HWS Temperature	AI		°C	High Temp. Loop
HWR Temperature	AI		°C	High Temp. Loop
HWS Low temperature alarm		10°C < setpoint	°C	High Temp. Loop
P-10 Enable/disable	DO			Low Temp H/C Loop
P-10 Status	DI			Low Temp H/C Loop
P-10 Fault	DI			Low Temp H/C Loop
P-11 Enable/disable	DO			Low Temp H/C Loop
P-11 Status	DI			Low Temp H/C Loop
P-11 Fault	DI			Low Temp H/C Loop
P-12 Enable/disable	DO			Low Temp H/C Loop
P-12 Status	DI			Low Temp H/C Loop
P-12 Fault	DI			Low Temp H/C Loop
Three-way Control Valve 1 Modulation	AO			Low Temp H/C Loop
Three-way Control Valve 1 Status	AI			Low Temp H/C Loop
Three-way Control Valve 2 Modulation	AO			Low Temp H/C Loop
Three-way Control Valve 2 Status	AI			Low Temp H/C Loop
HWS Temperature	AI		°C	Low Temp H/C Loop
HWR Temperature	AI		°C	Low Temp H/C Loop
HWS Low temperature alarm		12.8°C	°C	Low Temp H/C Loop
HWS High temperature alarm		35°C	°C	Low Temp H/C Loop
P-13 Enable/disable	DO			Glycol Heating Loop
P-13 Status	DI			Glycol Heating Loop
P-13 Fault	DI			Glycol Heating Loop
GWS Temperature	AI		°C	Glycol Heating Loop
GWR Temperature	AI		°C	Glycol Heating Loop
Three-way Control Valve HX-1 Modulation	AO			Glycol Heating Loop
Three-way Control Valve HX-1 Status	AI			Glycol Heating Loop
Three-way Control Valve PHC-1 Modulation	AO			Glycol Heating Loop
Three-way Control Valve PHC-1 Status	AI			Glycol Heating Loop

CONTROLS POINTS LIST

Controls Points List For New Equipment				
Description	**Type**	**Value**	**Units**	**System**
GWS Low temperature alarm		5°C < setpoint	°C	Glycol Heating Loop
MUA Filter Differential Pressure	AI		Pa	Building HVAC
MUA PHC-1 Differential Pressure	AI		Pa	Building HVAC
MUA PHC-1 Air Temperature	AI		°C	Building HVAC
MUA Supply Air Temperature	AI		°C	Building HVAC
MUA VFD Enable/disable	DO			Building HVAC
MUA VFD Alarm	DI			Building HVAC
MUA VFD Speed	AI			Building HVAC
MUA VFD Speed Control	AO			Building HVAC
EF-1 VFD Enable/disable	DO			Building HVAC
EF-1 VFD Alarm	DI			Building HVAC
EF-1 VFD Speed	AI			Building HVAC
EF-1 VFD Speed Control	AO			Building HVAC
SP-1 High Level Alarm	DI			Sump Pumps

3. PRODUCTS

.1 Not Applicable.

4. EXECUTION

.1 Refer to Section 23 09 33 for input/output designations.

END OF SECTION

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 The relationships between the points, systems and building are described in the control sequences.

.3 Review with the Contract Administrator during the Shop Drawing stage to finalise the control sequences for each system.

.4 All temperature setpoints mentioned below are initial setup values and shall be adjustable for future requirements.

2. PRODUCTS

.1 Not Applicable

3. EXECUTION

.1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

4. CONTROL SEQUENCES

4.1 Boiler Heating Loop

.1 The Boiler Heating Loop consists of two boilers (B-3 & B-4) and the immediate closed-loop interconnecting pipe.

.2 Boilers B-3 and B-4

.1 Boiler controls are provided by the boiler Manufacturer. Provide tie-in points to BAS, as indicated on the Points Schedule.

.2 Provide all safety or operational interlocks to boiler control panels as required.

.3 Boilers generate heat for a boiler heating loop of a maximum supply setpoint temperature of 62.8°C (145°F).

.4 Each boiler has five stages (total of ten stages between both boilers) of heat (20%, 40%, 60% etc) and will be staged by the BMS based on the requirements of the High Temperature Heating Loop. Each stage will have a minimum two minute delay.

.5 Boiler lead lag selection is to be automated by the BMS. Switchover of lead boiler shall be weekly.

.6 Boiler shall be locked out by safety features such as Low water cut-out, low flow condition at flow switch, fire alarm activation or opening of the Emergency Boiler disconnect switch at the entry to the new mechanical room in the basement.

.7 Provide an alarm to BAS if the boiler heating loop temperature drops below 29.4°C (85°F) during the heating season (when the OAT is below 3°C).

.8 The boilers are normally activated via the building automation system, when the outdoor air temperature drops below 20°C (68°F).

.3 Boiler circulation pumps.

.1 Boilers B-3 and B-4 each come with a factory mounted circulator.

.2 Circulator pump shall be controlled by on-board boiler control panel.

.3 Circulator shall use the default pump delay feature of the on-board controls to continue running the pumps for 1.0 minutes (adjustable from 0.1 to 10 minutes) after burners are off.

4.2 High Temperature Heating Loop

.1 The High Temperature Heating Loop contains one circulator pump (P-8) and receives heat injection from the Boiler Heating Loop. Heat is then injected to the Low Temperature Heating Loop and the Glycol Heating Loop via a series of 3-way control valves.

.2 The pump is normally activated via the building automation system, when the outdoor air temperature drops below 20°C (68°F).

.3 The water supply temperature of the High Temperature Heating Loop will be based on an outdoor reset schedule by staging the boilers as follows:

O/A Temperature	HWS
°C (-30°F) or less	°C (140°F)
°C (50°F) or higher	°C (100°F)

.4 The BMS shall send an alarm if the water supply temperature falls 10°C (18°F) below the outdoor reset schedule setpoint. In the event this happens, the BMS will activate the chilled water loop pump to inject heat from the existing boilers B-1/B-2.

4.3 Low Temperature Heating/Cooling Loop

.1 The Low Temperature Heating/Cooling Loop consists of two pumps (P-10 & P-11) in a duty/standby parallel arrangement which circulates water to the basement and main floor heat pumps.

.2 The loop will be maintained between (65°F) to (88°F) a year.

.3 Heat Injection

.1 Heat is injected into the Low Temperature Heating/Cooling Loop via the two three-way control valves located on the High Temperature Heating Loop.

.2 The two three-way control valves are in a duty/standby arrangement with BMS controlled switchover weekly.

.3 The duty three-way control valve will modulate open when the Low Temperature Heating/Cooling Loop drops to (65°F) and will close when the loop temperature reaches (71°F).

.4 The BMS shall send an alarm if the loop temperature falls to (55°F)

.4 Heat Rejection

.1 Heat is rejected out of the Low Temperature Heating/Cooling Loop via the Chilled Water Loop Pump (P-12).

.2 The Chilled Water Loop Pump will run when the Low Temperature Heating/Cooling Loop reaches (88°F) and will stop when the loop temperature reaches (82°F).

.3 The BMS shall send an alarm if the loop temperature reaches (95°F)

4.4 Glycol Heating Loop and Make-up Air Unit

.1 The major components of the glycol heating loop system consists of:

.1 Pre-heat coil (PHC-1) retro-fitted into the existing make-up air unit.

.2 Circulator pump (P-13)

.3 Heat exchanger (HX-1)

.2 The pump is normally activated via the building automation system, when the outdoor air temperature drops below 20°C (68°F).

.3 The glycol supply temperature will be controlled by the three-way valve located on the source side (water side) of HX-1. The glycol supply temperature setting shall be based on an outdoor reset schedule by modulating a 3-way control valve on the source (water) side of the heat exchanger as follows:

O/A Temperature	GLS
°C (-30°F) or less	°C (100°F)
°C (50°F) or higher	°C (80°F)

.4 The three-way control valve controlling flow to PHC-1 shall modulate to maintain a pre-heat temperature of 20°C (68°F).

.5 The existing make-up air unit gas burners shall remain as-is and will automatically heat the air at a preset temperature controlled by a stand-alone thermostat located in the existing mechanical room.

.6 The glycol supply and return temperatures along with the known flow rate of the pump will be used to calculate heat output of the pre-heat coil.

.7 The BMS shall send an alarm if the glycol supply temperature falls within 5°C (9°F) of the outside air temperature.

END OF SECTION

NATURAL GAS PIPING

1. GENERAL

1.1 Scope

.1 Provide new gas service complete:

.1 Gas Piping

.2 Fittings and Valves

.3 Pressure Regulators

.4 Testing

.5 Service Connections

1.2 References

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5, Pipe Flanges and Flanged Fittings.

.2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.4 ASME B18.2.1, Square and Hex Bolts and Screws.

.2 American Society for Testing and Materials (ASTM)

.1 ASTM A 47/A47M, Specification for Ferritic Malleable Iron Castings.

.2 ASTM A 53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM B 32, Specification for Solder Metal.

.4 ASTM B 75M, Specification for Seamless Copper Tube Metric.

.3 Canadian Standards Association (CSA)

.1 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.2 CAN/CSA B149.1, Natural Gas and Propane Installation Code.

1.3 Product Data

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

1.4 Closeout Submittals

.1 Provide maintenance data for incorporation into manual.

2. PRODUCTS

2.1 Pipe

.1 Steel pipe: to ASTM A 53/A53M, Schedule 40, seamless as follows:

.1 NPS 1/2 to 2, screwed.

.2 NPS 2 1/2 and over, plain end.

2.2 Jointing Material

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: non-metallic flat.

.4 Soldered: to ASTM B 32, 50/50.

2.3 Fittings

.1 Steel pipe fittings, screwed, flanged or welded:

.2 Malleable iron: screwed, banded, Class 150.

.3 Steel pipe flanges and flanged fittings: to ASME B16.5.

.4 Welding: butt-welding fittings.

.5 Unions: malleable iron, brass to iron, ground seat, to ASTM A 47/A47M.

.6 Bolts and nuts: to ASME B18.2.1.

.7 Nipples: Schedule 40, to ASTM A 53/A53M.

2.4 Valves

.1 Conform to CGA Standard 3.16.

.2 Provincial Code approved, lubricated plug type.

2.5 Pressure Regulator

.1 Self-operated gas pressure regulator; malleable iron body. Size for full gas load to reduce gas pressure from 35 kPa (5 psig) to 2.7 kPa (0.4 psig). Manufacturer: equal to Fisher.

3. EXECUTION

3.1 Piping

.1 Install in accordance with Section 23 05 01 - Common Work Results for Mechanical, supplemented as specified herein.

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

.3 Install in accordance with CAN/CSA B149.1.

.4 Install vent piping for all pressure regulators.

.5 Install drip points:

.1 At low points in piping system

.2 At connections to equipment

3.2 Valves

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

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

3.3 Pressure Regulator

.1 Main gas service distribution piping from gas meter is 34.5 kPa (5 psi). Contractor shall provide regulators and vent piping at each piece of gas fired equipment as per schedule below.

3.4 Field Quality Control

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

3.5 Purging

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

3.6 Pre-Start-Up Inspections

.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

.2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.7 Cleaning and Start-Up

.1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems, supplemented as specified herein.

.2 In accordance with requirements of CAN/CSA B149.1, supplemented as specified herein.

3.8 Performance Verification (P.V.)

.1 Test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Manual Air Vents

.2 Automatic Air Vents

.3 Air separators

.4 Relief Valves

.5 Glycol Solution

.6 Circuit Balancing Valves

.7 .By-pass Filter

.8 Glycol Fill Tank

.9 Expansion Tank

.10 Chemical Pot Feeder

1.2 Quality Assurance

.1 Thoroughly check system and make necessary corrections if system continually loses solution.

.2 Perform tests determining strength of glycol solution before system is turned over to the City. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

1.3 Submittals

.1 Provide Shop Drawings for all equipment in this Section.

2. PRODUCTS

2.1 Manual Air Vents

.1 Provide manual air vents with 25 mm or line diameter pipe which ever is greater to form air collection chamber. Collection chamber to be 150 mm high.

2.2 Automatic Air Vents

.1 Provide automatic air vents where shown on Drawings. Vents shall be non-ferrous construction, rated for 1000 kPag (145 psig) and 116°C (240°F) operating temperature.

.2 Standard of Acceptance: Bell & Gossett model 7 or 87.

2.3 Air Separators

.1 Provide tangential style steel construction air separator with low velocity vortex action. Maximum working pressure rated 1034 kPa (150 psi) and maximum operating temperature 177ºC (350ºF). Removable stainless steel strainer, blowdown connection and NTP vent connection.

.2 Reference to 23 06 21.19 Tank Schedule.

2.4 Relief Valves

.1 Provide ASME rated water pressure relief valve to protect glycol hot water system.

.2 Standard acceptance: Watts series 174A.

2.5 Glycol Solution

.1 Provide ethylene glycol/water solution mixed at a 50/50 ratio suitable for a temperature range of -40°C (-40°F) to 104°C (220°F). Solution to be suitable for heating or cooling complete with appropriate corrosion inhibitors. Solutions must be factory premixed. Applies only for load side of the heat exchanger (HX-1).

2.6 Circuit Balancing Valves

.1 Valves up to 50 mm: Brass body, stem and disk with reinforced nylon or ABS handwheel, Maximum rated pressure 2068 kPa (300 psi) and operation temperature from -20ºC to 150ºC.

.2 Valves 65 mm to 150 mm: Ductile iron body, bronze disk, high strength engineered resin seat, brass stem, BUNA N. & EPDM ”O” rings and drain tapings. Maximum rated pressure 1724 kPa (250 psi) and maximum operation temperature to 110ºC.

.3 Reference to 23 06 20.16 Circuit Balancing Valve Schedule.

2.7 Bypass Filter

.1 Unit to consist of cartridge filter, flow indicator, flow control valves and filter cartridges. Cartridge filter; stainless steel shell of single centre bolt construction with cast nick-plated brass head, drain plug and air vent. Flow indicator - cast bronze body with two sight glasses of high temper, thermo shock-resistant glass and nylon rotor on stainless steel pin.

.1 Flow Control Valves: Cast Bronze Globe Valves, 25 mm Female NPT.

.2 Filter cartridges: 10 each of 10 micron retention, and 20 micron retention.

.3 Manufacturer: Guthrie Hydroniclean System.

2.8 Glycol Fill Tank package

.1 Glycol Fill Tank package shall include 208 L (55 US gallon) storage/mixing tank with cover; pump suction hose with inlet strainer; pressure pump with thermal cut-out; integral pressure switch; integral check valve; cord and plug; pre-charged accumulator tank with EPDM diaphragm, manual diverter valve for purging air and agitating contents of storage tank; pressure regulating valve adjustable 35 to 380 kPa (5 to 55 psi) complete with pressure gauge; integral replaceable strainer; built-in check valve; union connection; 15 mm (0.5 inch) x 900 mm (36 inch) long flexible hose with check valve; low level pump cut-out; low level alarm panel with remote monitoring dry contacts. Power supply 115/1/60 0.7 A. Pump performance 0.09 L/s (1.4 usgpm) at free flow, 0.06 L/s (1.0 usgpm) at 345 kPA (50 psi), self-priming to 2.1 m (7 feet).

.2 Pressure pump shall be capable of running dry without damage.

.3 Unit shall be completely pre-assembled and certified by a recognized testing agency to CSA standard C22.2 No.68.

.4 Tank shall be completely full of premixed 50% ethylene glycol at time of turn over.

.5 Refer to Section 23 06 21.19 - Tank Schedule.

2.9 Expansion Tank

.1 Provide expansion tank as described in Section 23 06 21.19 - Tank Schedule.

2.10 Chemical Pot Feeder

.1 150 mm diameter x 550 mm long feeder, suitable for 1034 kPa (150 psi) operating pressure complete with isolation valves on 20 mm inlet and outlet lines. 20 mm drain valve 40 mm fill complete with filling funnel.

3. EXECUTION

3.1 General

.1 Do necessary piping to complete installation as shown on the Drawings specified.

.2 Thoroughly clean and flush system before antifreeze solution is added.

.3 Manually feed glycol to system through Glycol Fill Tank.

.4 Provide antifreeze solution lost from the systems from any cause other than neglect by the City during the first year of operation.

3.2 Air Vents

.1 Provide manual type at system high points and convection type heating units.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

3.3 Air Separator

.1 Provide on suction side of system circulation pump and connect to expansion tank.

3.4 Relief Valve

.1 Provide one (1) relief valve on glycol system and where indicated.

.2 Drain relief valve to glycol collection tanks. Do not waste glycol to floor drains.

.3 System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one line vents several relief valves, cross sectional areas shall exceed sum of individual vent areas.

3.5 Glycol Solution

.1 Provide one (1) five-USG pail of pre-mixed 50% ethylene glycol solution at project completion.

3.6 Circuit Balancing Valves

.1 Install valves up to 50 mm five pipe diameters downstream from a fitting or if a valve is located downstream from a circulation pump, allow ten pipe diameters from pump discharge.

.2 Install valves 65 mm to 150 mm five pipe diameters downstream from a fitting or if a valve is located downstream from a circulation pump, allow ten pipe diameters from pump discharge end. In both situations provide two pipe diameters downstream from the valve.

3.7 Bypass Filter

.1 Install between pump's suction and discharge. Provide isolation valves and sight glass as indicated.

3.8 Glycol Fill Tank package

.1 Provide one (1) tank package for each glycol system.

3.9 Expansion Tanks

.1 Provide air lines, checks, charging valves and pressure gauges for expansion tanks and glycol fill tanks. Charging valves to be piped to 1200 mm above finished floor.

3.10 Chemical Pot Feeder

.1 Install one (1) chemical pot feeder for each glycol system.

END OF SECTION

HYDRONIC PUMPS

1. GENERAL

1.1 Scope

.1 All pumps except where integral with a manufactured piece of equipment.

1.2 Submittals

.1 Submit with Shop Drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Show pump weights, motor and pump operating or efficiencies and electrical power characteristics.

1.3 Quality Assurance

.1 Pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.

.3 Motors shall be high efficiency only as per NEMA Standards.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Pumps shall operate at 1750 rev/min unless specified otherwise.

.3 Pump connections shall be flanged.

2.2 Vertical In-Line Pump

.1 Type: Centrifugal, single stage, close coupled in-line, back pullout design, suitable for vertical operation.

.2 Casing: Cast iron, rated for minimum of 1200 kPa (175 psi) working pressure. Suction and discharge gauge port, air vent, wear rings, seal flush connection, drain plug, flanged suction and discharge.

.3 Impeller: Brass with stainless steel lock nut and capscrew.

.4 Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber.

.5 Seals: Buna-Carbon/Ceramic.

.6 Motor: Open drip proof unless noted otherwise in pump schedule.

2.3 In-Line Circulator

.1 Casing: Cast Iron rated for 1034 kPa (150 psi) working pressure.

.2 Impeller: Glass filled Noryl or PPS.

.3 Shaft: Stainless Steel.

.4 Seal: Carbon on Silicon Carbide.

.5 Motor: Open drip proof.

3. EXECUTION

3.1 Installation

.1 Provide air cock and drain connection on horizontal pump casings.

.2 Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 100 mm and over.

.3 Check and align pumps prior to start-up.

3.2 Performance

.1 Refer to the Pump Schedule in Section 23 06 21.13.

END OF SECTION

METAL DUCTS

1. GENERAL

1.1 Scope

.1 Ductwork and plenums

.2 Fasteners

.3 Sealants

1.2 Definitions

.1 Low Pressure: static pressure in duct less than 500 Pa (2 in.wg.) and velocities less than 10 m/s (2000 fpm).

.2 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.3 Quality Assurance

.1 Ductwork shall meet the requirements of NFPA No. 90A - Air Conditioning and Ventilating Systems; and NFPA No. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

.3 Flexible air duct shall conform to NFPA 90A and UL181 standard for factory made air duct materials and air duct connectors.

1.4 Submittals

.1 Submit Shop Drawings and samples of duct fittings for approval, including particulars such as gauge sizes, welds and configurations prior to start of work.

1.5 Alternatives

.1 Obtain written permission from the Contract Administrator prior to making variations in duct configuration or sizes. Size alternatives using ASHRAE table for circular equivalents of rectangular ducts.

2. PRODUCTS

2.1 Materials

.1 Ducts: galvanised steel lock forming quality, having galvanised coating of 380 g/m^2 (1.25 oz/ft^2) for both sides.

.2 Fasteners: use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts. Weld kitchen exhaust ducts.

.3 Sealant: water resistant, fire resistive, compatible with mating materials.

.4 Flexible Duct - Low Pressure: flexible air duct shall be used where shown on drawings. Length of flexible duct shall not exceed 900 mm. Flexible duct shall be polymetric liner banded to a steel wire helix, wrapped with fiberglass insulation and outer fiberglass reinforced metalled vapour barrier jacket. Flexible duct rated for 12 m/s (2400 fpm) velocity and pressure rated for 500 Pa (2 in.wg.) positive and 500 Pa (2 in.wg.) negative.

.1 Standard Acceptance: Thermaflex M-KE.

.5 Flexible Duct - Medium and High Pressure: flexible air duct may be used to connect terminal units to metal duct. Length of flexible duct shall not exceed 300 mm. Flexible duct shall be woven and vinyl coated fiberglass liner bonded to a steel wire helix. Where flexible air duct is attached to metal insulated duct, furnish flexible air duct with fiberglass insulation and outer fiberglass reinforced metalled vapour barrier jacket. Flexible duct rated for 30 m/s (6000 fpm) velocity and pressure rated for 4.0 kPa (16 in.wg.) positive and 500 Pa (2 in.wg.) negative.

.1 Standards of Acceptance:

.1 Uninsulated - Thermaflex S-TL; Insulated - Thermaflex M-KC.

3. EXECUTION

3.1 Plenum Gauges

.1 Fabricate fan plenums and plenums downstream of fan in accordance with SMACNA manual.

.2 Fabricate plenums between fan and upstream apparatus of 1.6 mm (16 ga) thick material.

.3 Fabricate plenums between filters and upstream apparatus of 1.3 mm (18 ga) thick material.

3.2 Duct Sealing

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, should be sealed using:

.1 Low Pressure Ductwork:

.1 Slip Joints: apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5 mm (0.06 in) use heavy mastic type sealant.

.2 Flanged Joints: soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.

.3 Other Joints: heavy mastic type sealant.

.2 Medium and High Pressure Ductwork: combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Duct tapes as sealing method are not permitted.

.3 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.4 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the Engineer.

.5 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

3.3 Installation

.1 Locate ducts with sufficient space around equipment to allow normal operation and maintenance activities.

.2 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.3 Interrupt duct linings at fire, balancing backdraft and smoke dampers so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both sides of damper device.

.4 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.

.5 Protect carbon steel ductwork exposed to weather by painting or coating with suitable weather resistant material.

.6 Do not use flexible duct to change direction. Provide a minimum of three (3) duct diameters of straight metal duct between box inlet and flexible connector.

.7 Connect diffusers or troffer boots to low pressure ducts with 300 mm maximum length of flexible duct. Hold in place with caulking compound and strap or clamp.

.8 Prove that ductwork is substantially airtight before covering or concealing.

.9 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters or bypass during cleaning.

.10 Fabricate ductwork from field measurements and not from plans and shop drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.11 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm, cross brace for rigidity. Open corners are not acceptable.

.12 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.13 Construct tees, bends and elbows with radius of not less than 1-1/2 times width of cut on centre line. Where not possible and where rectangular elbows are specified, provide double wall air foil type turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibreglass inside.

.14 Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.

.15 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Seal seams on fresh air and exhaust ducts watertight with mastic or low velocity duct sealant.

.16 Set plenum doors 150 mm above floor. Arrange door swings so that fan static holds door in closed position.

END OF SECTION

FIRE DAMPERS

1. GENERAL

1.1 Scope

.1 Duct Fire Dampers

.2 Door Fire Dampers

.3 Duct Access Doors

1.2 Quality Assurance

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S 112 “Fire Dampers”.

.2 Fusible links on fire dampers shall be constructed to ULC Standard S 505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and City’s Representative.

.4 Access doors shall be ULC labelled.

.5 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

.6 Prove all dampers to inspector at job completion.

1.3 Submittals

.1 Submit Shop Drawings of factory fabricated assemblies.

2. PRODUCTS

2.1 Duct Access Doors

.1 Fabricate rigid and close-fitting doors of galvanised steel with sealing gaskets and suitable quick fastening locking devices. Duct access panels with screws are not acceptable. Install minimum 25 mm thick insulation with suitable sheet metal cover frame for insulated ductwork.

.2 Fabricated with two butt hinges and two sash locks for sizes up to 450 mm two hinges and two compression latches with outside and inside handles for sizes up to 600 mm x 1200 mm and an additional hinge for larger sizes.

2.2 Duct Fire Dampers

.1 Fabricate of galvanised steel or prime coated black steel weighted to close and lock in closed position when released by fusible link.

.2 Fire dampers shall be curtain type with damper blades retained out of air stream in a recess so free area of connecting ductwork is not reduced.

.3 Fusible links shall be set for 71°C (160°F).

2.3 Door Fire Dampers (TA-1)

.1 Door louver type fire damper with 1.5 hr fire rating.

.2 Material: 16 gauge CRS frame and louver blades

.3 Construction: Mitered and welded corners; screws fasted through prepared frame into louver core; spring-loaded fusible link mechanism incorporated into design. Upon melting link, action bar is actuated thereby closing and locking all blades.

.4 Finish: Baked on gray powder coat.

.5 Free Flow Area: 45% free area.

.6 Standard of Acceptance: Air Louvers Inc Model 1900-A.

3. EXECUTION

3.1 Application

.1 Provide access door minimum 450 mm x 350 mm or 50 mm smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:

.1 At each fire damper location.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.3 All fire dampers and fire stop flaps are to be left in the closed position for balancing contractor to fix open.

END OF SECTION

PANEL AIR FILTERS

1. GENERAL

1.1 Scope

.1 Pleated filters

1.2 Quality Assurance

.1 Filters shall be product of and supplied by one Manufacturer.

.2 Filter media shall be ULC listed, Class I or Class II.

.3 Filter components assembled to form filter banks shall be products of same Manufacturer.

.4 All filters except HEPA shall be in accordance with ASHRAE Standard 52.76.

.5 Filters containing asbestos, urea formaldehyde or fibreglass will not be accepted.

1.3 Alternatives

.1 Size, media face area, material, test efficiency, initial and final air resistance of alternative manufacturers shall be as specified.

1.4 Submittals

.1 Provide Shop Drawings of all filters, and filter racks/housings.

2. PRODUCTS

2.1 Frames

.1 Fabricate filter frames and supporting structures of galvanised steel or extruded aluminum with necessary gasketting between frames and walls. Provide holding frames 1.6 mm (16 ga), "T" section construction.

.2 Provide standard size frames to provide interchangeability of filter media of other Manufacturers.

2.2 Pleated Filters

.1 Media: The filter shall be constructed of non-woven reinforced cotton rayon. A diamond grid with 98% open area shall provide support for the media. The media shall be bonded to media support to ensure pleat stability. A rigid, moisture resistance heavy duty kraft board shall enclose the media. The filter pack shall be bonded to the inside periphery of the frame to eliminate air bypass.

.2 The efficiency shall be minimum MERV 8 at up to 2.5 m/s (500 fpm) unless otherwise specified.

.3 Filters shall be minimum 50 mm (2 inch) thick unless otherwise specified.

3. EXECUTION

3.1 Installation

.1 Construct and install filters to prevent passage of unfiltered air. Provide felt, rubber or neoprene gaskets.

.2 Do not operate fan system connected to filter banks until filters (temporary or permanent) are in place. Replace pre-filters every three (3) months if equipment is used during construction and install new pre-filters at the time of air balancing.

.3 Provide two (2) complete spare sets of new filters and for all air handling equipment at take-over by the City (i.e. at Total Performance).

.4 Provide filter banks in arrangement shown with removal and access indicated.

END OF SECTION

CONDENSING BOILERS

1. GENERAL

1.1 Scope

.1 Boilers, Control and Trim

.2 Hot Water Connections

.3 Fuel Connections

.4 Electrical connections, Controls and Power

.5 Flue, Draft Damper and Flue Stack Connection

1.2 Quality Assurance

.1 Boilers to comply with Provincial Regulations and bear the CSA Approval Stamp/Seal.

.2 Boilers shall each have a Canadian Registration Number (CRN) and shall be approved and labelled by the UL/ULC.

1.3 Start-up

.1 Provide the services of a factory trained representative to start up the boiler(s), test the efficiency and train the operators.

1.4 Submittals

.1 Submit Shop Drawings indicating capacity rating, physical dimensions, wiring diagrams, materials of construction, code compliance, etc.

2. PRODUCTS

2.1 Boiler Construction

.1 Boiler shall be natural gas fired high efficiency (95%+) condensing boiler with lower NOx emission not exceeds of 10 ppm.

.2 The burner design has a capable of modulation down to 20% of full fire (5:1 turndown) without loss of combustion efficiency. Sealed combustion chamber shall incorporate for a pre-mix stainless steel burner with 100 mm air intake connection.

.3 Stainless steel heat exchanger with welded construction shall be ASME “H” stamped for a working pressure not less than 1103 kPa (160 psig). The boiler shall have an ASME approved relief valve with a setting of 1034 kPa (150 psig)).

.4 Exhaust manifold shall be of corrosion resistant with a 100 mm diameter vertical flue connection.

.5 Built-in condensation trap with drain valve and trap outlet not lower than 330 mm from the bottom.

.6 The boiler shall be supplied with boiler circulation pump mounted and wired inside jacket and pump control shall be equipped with delay.

2.2 Boiler Trim

.1 The boiler shall be supplied safeguard system utilising spark ignition, temperature and pressure gauge, water flow switch, low water cut-off and burner site glass.

2.3 Boiler Controls

.1 The boiler shall be supplied electronic PID modulation control with large user-interface, display, alarm outputs, and external (4-20mA) modulation control.

.2 The boiler shall be equipped with interface to BMS.

2.4 Boiler Air Intake and Venting

.1 Each boiler shall be supplied with horizontal air intake and vent terminals from boiler supplier.

.2 The vent materials shall be ULC-S636 Certified or Marked.

3. EXECUTION

3.1 Installation

.1 Follow Manufacturers recommended installation guidelines.

.2 The relief pressure of the PRV shall be set at 1034 kPa (150 psig).

.3 The first three feet of venting must be accessible for visual inspection.

.4 Provide a discharge pipe for the PRV and route pipe to nearest funnel floor drain. Discharge pipe cross-sectional area shall not be less than the area of the boiler PRV outlet.

.5 Provide condensate drainage piping to neutralization tank.

3.2 Equipment Stands

.1 Provide a prime and painted steel stand for each boiler. Stand shall be 300 to 400 mm high.

3.3 Housekeeping Pads

.1 Mount boilers and equipment stands on 100 mm housekeeping pads.

3.4 Performance

.1 Refer to section 23 06 50.13 Condensing Boiler Schedule.

3.5 Warranty

.1 Provide minimum twelve (12) years warranty on boilers.

END OF SECTION

PLATE AND FRAME HEAT EXCHANGERS

1. GENERAL

1.1 Scope

.1 Heat exchanger

.2 Relief and drain valves

.3 Instrumentation

.4 Piping connections

.5 Steel supports

1.2 Quality Assurance

.1 Conform to requirements of CGA, CSA, Provincial and Municipal Codes and be CSA listed.

.2 Design and construction shall meet requirements of ASME code for unfired pressure vessels and provincial codes.

.3 To comply with AHRI 400: Liquid to liquid heat exchanger.

1.3 Submittals

.1 Provide Shop Drawings including dimensions, locations and size of tapping, and performance data to match Specification.

2. PRODUCT

2.1 General

.1 Units shall be suitable for 1,034 kPa (150 psig) working pressure and 150°C (302°F) working temperatures.

.2 Prime coat exterior of units.

2.2 Plate and Frame Heat Exchanger

.1 Frame: Carbon steel frame consisting of one stationary plate cover with inlet and outlet NPT female connections, moveable plate cover, upper carrying bar, lower guiding bar, and support column.

.2 Plate material and thickness: AISI 316 stainless steel with thickness of 0.5 mm (0.02”).

.3 Plate mixture: TKTL-30.

.4 Nitril gaskets and groove seals.

.5 ASME approved with “U” stamp.

2.3 Flush Connections

.1 Provide a flush connection for the inlet and outlet of the hot and cold sides of the heat exchanger piping as detailed on Drawings. Each flush connection shall have a shut-off valve with NPT female connection and capped.

3. EXECUTION

3.1 Installation

.1 Provide welded structural steel stands for floor mounting of heat exchangers. Bolt stand to floor.

.2 Ensure installation permits removal of plates without disturbing installed equipment or piping. Provide installation clearances in accordance with Manufacturer's recommendations.

.3 Refer to Drawings for details of installation and piping connections.

3.2 Performance

.1 Refer to Section 23 06 21.16 Plate and Frame Heat Exchanger Schedule

END OF SECTION

CUSTOM PACKAGED, OUTDOOR, HEATING AND VENTILATING MAKE-UP AIR UNITS

1. GENERAL

1.1 Scope

.1 The existing make-up air unit located on the roof of the mechanical room shall have the following modifications.

.1 Upgrade existing 2.2 kW. Motor with a new 5.6 kW motor.

.2 Modify existing filter rack as per Drawings.

.3 Provide new preheat coil in make-up air unit.

1.2 Quality Assurance

.1 Comply with local and Provincial Regulations and have CSA and CGA approval stickers.

.2 All components shall be product of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products.

.3 Filter media shall be UL/ULC listed, Class I or Class II as approved by local authorities.

.4 Test operation of the unit after installation.

2. PRODUCTS

2.1 Motors

.1 5.6 kW inverter duty motor, 208/3/60.

.2 Motor shall comply with 23 05 01 - Common Work Results for Mechanical.

2.2 Coils

.1 Refer to 23 82 16 - Air Coils.

.2 Provide a stainless steel drip pan under coil complete with insulated and trapped condensate drain line to discharge outside of the make-up air unit.

2.3 Filters

.1 Refer to 23 41 13 Panel Air Filters.

.2 Provide 6 new – 510 x 610 x 50 (20 x 24 x 2) filters for the Make-up Air Unit immediately after commissioning of the HVAC systems.

.3 Provide the City with two (2) spare sets (6 filters per set) at Total Performance.

3. EXECUTION

3.1 Installation

.1 Remove and replace existing motor with new larger motor and provide VFD control.

.2 Remove and re-install existing filter rack as per Drawings.

.3 Install new pre-heat coil as per Drawings.

.4 Provide all required pulleys, sheaves and belts to allow increase in air flow by approximately 10%. Provide re-balancing of newly modified make-up air unit to supply minimum 3,000 LPS. Use new VFD to reduce air flow to 2,900 LPS.

END OF SECTION

AIR COILS

1. GENERAL

1.1 Scope

.1 Glycol coils

.2 Coil installation

.3 Coil piping and accessories

1.2 Quality Assurance

.1 Coils shall be the product of Manufacturer regularly engaged in production of coils who issues complete catalogue data on such Products.

.2 Coil capacities, pressure drops, and selection procedures shall be certified in accordance with AHRI Standards and bear AHRI seal.

1.3 Submittals

.1 Shop Drawings shall include dimensions, materials of construction and performance data to match Specifications.

.2 Submit coil selection sheets or computer calculations with Shop Drawings.

2. PRODUCTS

2.1 General

.1 Provide extended surface type coils with tubes of copper or brass, and plate of helical type fins of copper or aluminium.

.2 Space fins 14 fpi maximum. Helical fins may be crimped.

.3 Mount coil section in galvanised steel casing designed for bolting to other sections of ductwork.

2.2 Pre-Heating Coils

.1 Design for maximum operating limits of 1,724 kPa (250 psig) and 149°C (300°F).

.2 Provide cast iron coil headers, copper tube carbon steel connection pipe.

.3 Provide vent and drain plugs on the coil header.

.4 Face length shall not exceed 3 m.

3. EXECUTION

3.1 Installation

.1 Support coil sections on steel channel or double angle frames and secure to casings. Arrange supports for cooling coils so they do not pierce or short circuit drip pans. Level serpentine coils and install drainable tube coils with pitch within casing. Arrange galvanised steel casings for bolting to other section, ductwork or unit casings. Provide airtight seal between coils and duct or unit cabinets.

.2 Make necessary connections to coils, including valves, air vents, unions and connections from drip pans. Provide isolating valve on supply line and eccentric plug valve on return line to each water coil.

.3 Locate water supply at bottom of supply header and return water connection at top to provide self-venting and reverse return arrangement. Provide manual air vents at high points complete with stop valves. Ensure water coils are drainable and provide drain connection at low points.

.4 Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins unless required to be replaced.

.5 If turn over occurs during winter months, turn over systems to the City with all chilled water cooling coils drained and valved off from the system.

.6 Install in accordance with Manufacturer's recommendations.

3.2 Performance

.1 Refer to 23 06 80.23 Air Coil Schedule.

END OF SECTION