Specifications

Victoria School Condominiums

#5

arriva

TORODE Residential LTD.

VOLUME
DIVISION
Issued for Tower Construction
Mechanical

Project #: 202-131

July 25, 2005

LEDCOR CONSTRUCTION

BKDI ARCHITECTS

1. GENERAL

1.1 Conformance

.1 Conform to Division I, General Requirements.

1.2 Scope

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

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

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

.4 Install equipment generally in locations and routes shown close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost. Coordinate with other trades prior to installing piping or equipment. If conflicts are found, notify consultant for instruction. Extras for improper coordination and removal of equipment to permit remedial work shall not be allowed.

.5 The drawings indicate the general location and route to be followed by the piping and ductwork. Where details are not shown on the drawings or only shown diagrammatically, the pipes and ductwork shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to Building Lines. All duct and pipes at ceiling shall be kept as tight as possible to beams or other limiting members at high end. All pipes and ducts shall be co-ordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed and dimensioned otherwise on drawings and permitted otherwise by the Consultant.

.6 Should inconsistencies exist such as the drawings disagreeing within themselves or with the specifications, the better quality and/or greater quantity of work or materials shall be estimated upon, performed and furnished unless otherwise ordered by the Consultant in writing during the bidding period.

.7 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the owner. Uncrate equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories

.8 Work shall be co-ordinated with the owner seven days prior to work commencing.

.9 Provide the Consultant with detailed construction, shop drawing, and delivery schedule within seven days of contract award.

2. RELATED REQUIREMENTS

.1	Submittals:	Section 01300
.2	Temporary Facilities:	Section 01500
.3	Temporary Heat:	Section 01500

3. RELATED WORK SPECIFIED IN OTHER SECTIONS

.1	Service and connections:	Section 01041 & 15401
.2	Excavations and backfilling:	Section 02200.
.3	Electric motor power characteristics:	Division 16
.4	Painting of mechanical work:	Section 09910
.5	Cast in place concrete and	Section 03300-Cast-In-Place
.6	Casting-in of anchoring devices:	Section 03100 - Formwork

4. COORDINATION OF WORK

.1 Co-operate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

5. MATERIALS

.1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or manufacturer for each specified application.

.2 Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level.

.3 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.

6. 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 respective specifications.

7. CUTTING AND PATCHING

.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

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

.3 Obtain written approval from Consultant before cutting or burning structural members. This work shall be carried out by the specialist trade only.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes larger than 100 mm in diameter tight to columns shall not exceed 200 mm in diameter. Cast or field cut holes smaller than 100 mm.

.5 Repair building where damaged from equipment installation, improperly located holes etc. by this section of the work. This repair work shall be carried out by the specialist trade at the expense of this section of work. Use matching materials as specified in the respective sections.

8. SHOP DRAWINGS

.1 Provide shop drawings as indicated in accordance with 01300.

.2 Identify materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalog material. Do not assume applicable catalogues that are available in the Consultant's office. Maintenance and operating manuals are not suitable submittal material.

.3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, eg. ratings, capabilities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps, seals, material, or painting.

.4 Include dimensional and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes.

.5 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Consultant.

.6 Shop drawings not requested will not be reviewed and processed by the Consultant.

.7 Do not order equipment or material until the Consultant has reviewed and returned shop drawings.

.8 Shop drawings shall be reviewed by the General Contractor and Mechanical Sub-Contractor indicating that the shop drawings have been reviewed, co-ordinated with the work and that the shop drawings are submitted without qualifications. Shop drawings shall bear the 'reviewed' stamp dated and initialled by the contractor and mechanical sub-contractor prior to submitting the shop drawings to the consultant. Shop drawings which do not bear the contractors and sub-trades 'reviewed' stamp, initials and date will be rejected and sent back as 'not reviewed'.

.9 Submit weights of all major equipment for review such that the loads can be reviewed by the appropriate Consultant.

9. STANDARDS OF MATERIALS, EQUIPMENT AND INSTALLATION

.1 Requests for changes to the specification in standards, materials, equipment or installation techniques shall be submitted for review five (5) working days prior to close of tenders, and if applicable will be incorporated in an Addendum to the Specification.

.2 Equipment used shall not exceed space limitations in any dimension. Replace any equipment or apparatus which does not meet this Specification at no cost. Assume full responsibility for the expense of redesign and adjustment to other parts of the building when proposing the use of acceptable equal or alternate equipment. It is the contractors responsibility to confirm all quantities. Dimensions, performance and accessories required for all equipment, including matching "standard" and operational accessories between "equal" and "acceptable" products/suppliers/manufacturers.

.3 Submit samples, in addition to drawings, of all items which in the Consultant's judgement, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.

.4 Provide equipment from the following manufacturers. Those manufacturers not listed are considered as alternatives. All mechanical equipment shall have the manufacturers name permanently affixed to it. It is the responsibility of both the 'named' product/supplier as well as the following listed "acceptable" products/suppliers to ensure that they meet or exceed the scheduled performance and are suitable for the intended use.

.5 Alternate manufacturers may be shown along with savings if so desired, however these alternatives must be shown in addition to a manufacturer from the acceptable list.

.6 If requested after contract award, provide within 24 hours a list of equipment and manufacturers to be used on this project. This list shall not be deviated from unless delivery, performance, or dimension issues require a change to be reviewed by the Consultant.

.7 Equipment on acceptable manufacturers list must be equal or better in quality and performance of the model specified. Equipment which is not equal will be replaced with the specified equipment at no cost to the Owner.

.8 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert the specified product and manufacturer for this project.

.9 The equipment manufacturer shall ensure that the strength and anchorage of the internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

ITEM	ACCEPTABLE PRODUCTS/ SUPPLIERS/MANUFACTURERS
Access Doors	Acudor, Maxam, Steel Brothers, Milcor,
Automatic Air Vent	Hoffman, Braukman, Sarco, Armstrong
Backflow Protection	Watts, Beeco, Ames, Wilkins
Boilers – Water Tube	Raypack, Laars. RBI, Superhot, Camus
Chillers/Air Cooled	Carrier
Chimneys	Selkirk, Belvent, Ecco
Coils, Water	Trane, McQuay, Carrier, Engineered Air
Coils, Electric	Federal, Chromalox, Qmark
Controls	Carrier
Couplings	Victaulic, Grinnell
Damper - Low Leakage	Tamco
Domestic Hot Water Heaters	John Wood, State, A.O. Smith, P.V.I., Ruud, Jetglass
Direct and Indirect Fired Make-up Air	Engineered Air, ICE
Duct Spiral and Fittings	United Sheet Metal, Ecco, Spiro-Lok
Expansion Joints	Flexonics, Hyspan, Uniroyal, Keflex, Mason, Goodall
Fans, Cabinet	Delhi, Greenheck, Acme, Lau, Penn
Fans, Ceiling	Greenheck, Delhi, Penn, Broan, Cook, Nutone
Fans, Centrifugal	Buffalo, Northern Blower, Pace, Barry, Twin City
Fan Coil Units	Carrier
Fans, Circulating	Nutone, Canarm, Banvige
Fan Propeller	Cook, Penn, Jenn-Air, Greenheck
Fans, Roof Mounted Exhaust	Penn, Jenn-Air, Greenheck, Delhi, Acme, Cook
Filter Gauges	Dwyer, Cambridge
Filters	Farr, Continental, Cambridge, AAF
Fire/Smoke Dampers	Canadian Advanced Air, Maxam, Ruskin, Controlled Air, Nailor-Hart
Fire Protection - Cabinets & Extinguishers	Wilson & Cousins, National, Viking, CFH
Fire Protection – Sprinklers	Grinnell, Viking, Star, Central (except "Omega" style sprinklers), Reliable
Fire Stopping/Smoke Seals	Hilti Firestop Systems, Firestop Systems Inc.
Flow Meters	Western Meter, Annubar, PSE, Bell & Gossett, Armstrong
Flush Valves	Zurn, Crane, Sloan, Cambridge Brass
Flexible Air Duct	Thermoflex, Wiremold, Flexmaster

ITEM	ACCEPTABLE PRODUCTS/ SUPPLIERS/MANUFACTURERS
Force Flow Units/Unit Heaters (Hot Water)	Trane, Rosemex, McQuay, Engineered Air
Garburators	Insinkerator, Hobart
Gas Detectors CO & Combustible Gas Detectors	C.E.T., QEL, Airtest
Gravity Ventilation	Penn, Greenheck, Acme, Alumivent
Grilles, Diffusers and Registers	E.H. Price, Krueger, Titus, Nailer-Hart
Hot Water Convectors	Dunham Bush, Trane, Engineered Air, Slant-Fin
Heat Exchangers – Shell and Tube	Armstrong, Leitch, Bell & Gossett
Heat Exchangers - Plate	Tranter, Alpha-Laval, Bell & Gossett, Armstrong
Insulation – Duct	Fiberglas, Knauf, Johns-Manville, Atlas, PPG, Manson
Insulation - Flexible Duct	Flexmaster
Insulation - Flexible Piping	Armstrong, PPG, Knauf, Johns-Manville, Manson
Insulation – Piping	Fiberglas, Knauf, Johns-Manville, Manson, Atlas, PPG
Jacketing Material	Childers, Fiberglas, Johns-Manville, Flamex FR Canvas
Louvres	Airolite, Penn, Westvent, Alumavent, Ruskin
Mixing Valves	Leonard, Bradley, Powers, Symmons, Lawler
Motors, Electric	Century Electric "E Plus iii", Baldor "Super-E", Toshiba "EQP 34", Teco "Max-E1"
Pipe Fittings and Flanges	Crane, Grinnell, Jenkins, Victaulic, Mech-Line
Pipe Supports and Hangers	Crane, Unistrut, Grinnell, Sarco
Plumbing Drainage Accessories	J.R. Smith, Enpoco, Zurn, Ancon
Plumbing Trim (All to be CSA approved)	Amercian Standard, Kohler, Eljer, Bradley, Powers, Crane, Symmons, Moen, Delta, Brasscraft, Emco, Acorn, Briggs, Chicago
Plumbing Fixtures (All to be CSA approved)	Crane, K.I.L., Fiat, Kohler, Eljer, American Standard, AristaNewman, Haws, Elkay, Aquarius, Jucuzzi, Sunroc, Western, Swan, Bradley, Valley, Hytec, Watrous, Briggs, Waltec
Pumps (Fire) Inline & Base	Aurora, Bell & Gossett, Darling
Pressure Gauges	Weiss, Ametek, Trerice, WGI
Pumps - Base Mounted	Aurora, Bell & Gossett, Darling, Armstrong, Leitch
Pumps – Fuel	Delaval, Viking
Pumps - In-Line	Bell & Gossett, Aurora, Armstrong, Paco, Grund Fos., Leitch, Taco
Pumps (Sewage & Storm)	Hydro-Matic, Toran, Flygt, Meyers, Zoeller, Gould, Barner Myers
Radiation (Residential Suites)	Slant-Fin

ITEM	ACCEPTABLE PRODUCTS/ SUPPLIERS/MANUFACTURERS
Radiation	Trane, Engineered Air, Dunham Bush, Rosemex, Slant-Fin
Relief Valves	Crosby, Sarco, Watts
Sound Attenuation	I.A.C., Vibron, Vibro Acoustics, Wisp Air
Strainers	Red & White, Crane, Sarco, Armstrong, Kitz, Mueller
Tanks (Expansion)	Anthes, Leitch, Armstrong, Enermax, B&G, Ferro, Expanflex, Amtrol, Clemmer, Westeel
Tanks (Oil Storage - Steel)	Tidy Welders, ANTHES, Clemmer
Tanks (Oil Storage - Fiberglass)	CAE, Actiplast, ZCL
Tanks (DHW Storage)	Leitch, Westeel, Anthes, Clemmer, Enermax, P.V.I., AO Smith
Thermometers	Trerice, Weiss, Weksler, WGI
Toilet Seats	Beneke, Bemis, Olsonite, Moldex, Sperzel, Centoco
Valves – Ball	Victaulic, Red & White, Grinnell, Jenkins, Watts, Crane, Kitz, Nibco
Valves - Gate & Globe	Red & White, Crane, Jenkins, Kitz Grinnell, Nibco
Valves – Butterfly	Red & White, Keystone, Grinnell, Nibco, Crane, Jenkins
Valves – Balancing	DeZurik, Dahl, Grinell, Red & White, Jenkins
Valves - Balancing/Flow Meter	T/A, Bell & Gossett, Armstrong, Grinnell
Valves - Check Spring Loaded	Victaulic, Mission, Moyes & Groves, Grinnell, Crane
Vibration Control Equipment	Vibro-Acoustics, Lo-Rez, Vibron, Mason
Water Treatment	Calgon, IPAC, Pace, Betz
Water Pressure Reducing Valves	Wilkins, Slinger, Watts, Clayton, Conbraco

10. PERFORMANCE VERIFICATION OF INSTALLED EQUIPMENT

.1 Installed mechanical equipment whose performance is questioned by the Consultant, may be subject to performance verification as specified herein.

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

.3 The Consultant will determine by whom testing shall be carried out. When requested, the contractor shall arrange for services of an independent testing agency.

.4 Testing procedures shall be reviewed by the Consultant.

.5 Maintain building comfort conditions when equipment is removed from service for testing purposes.

.6 Promptly provide the Consultant with all test reports.

.7 Should test results reveal that originally installed equipment meets specified performance requirements, Owner will pay all costs resulting from performance verification procedure.

.8 Should test results reveal that equipment does not meet specified performance requirements, equipment will be rejected and the following shall apply:
- .1 Remove rejected equipment. Replace with equipment which meets requirements of Contract Documents including specified performance requirements.
- .2 Replacement equipment will be subject to performance verification as well, using same testing procedures on originally installed equipment.
- .3 Contractor shall pay all costs resulting from performance verification procedure.

11. OPERATING AND MAINTENANCE DATA

.1 Instruct the building operators in the operation and preventative maintenance of each piece of equipment and system supplied and installed. Complete and turn over documentation prior to substantial performance.

.2 Provide operation and maintenance data as required under Section 01300.

.3 Provide three (3) copies to owner and one (1) copy to Consultant of hard cover extension type binders bound with heavy dark green fabric with hot stamped gold letters on front and spine indicating Mechanical Operating and Maintenance Manuals, Arch., Mech. Engineering Firm, Contractor's and Project Name.

.4 Index Division 15 of maintenance manuals according to the following index system.

.5 Tab 1.0 Mechanical Systems:
- .1 Provide title page with clear plastic cover.
- .2 The front title page shall include the cover information in addition to:
  - The Owner
  - The Architect
  - The Engineer
  - The General Contractor
  - The Mechanical Contractor
  - The Agency preparing the Manuals
- .3 The addresses, phone and fax numbers for the above will be given adjacent to their name.

.6 Tab 1.1 List of Mechanical Drawings.

.7 Tab 1.2 Description of Systems:
- .1 Provide complete description of each system.
- .2 Include detailed system description and components comprising that system, explanation of how each component interfaces with others to complete the system, location of each thermostat, controller, or operating setpoints.
- .3 Provide a complete description of emergency shut-down and start-up procedures for all major equipment, systems and controls, including fire

alarm functions, power failure mode, back-up equipment/systems operation.

.8 Tab 1.3 Operating Division:
- .1 Provide complete and detailed operation of each major component.
- .2 Include starting procedure, exact switch and control location.
- .3 Describe operation of component controls, changes required for summer or winter operation and method of accomplishment.
- .4 Describe trouble shooting sequence when set points can not be maintained.
- .5 Describe safe guards to check if equipment goes off line.
- .6 Describe fire protection and smoke control.

.9 Tab 1.4 Maintenance and Lubrication Division:
- .1 Provide detailed preventative maintenance and lubrication schedule for each of the major components including daily, weekly, monthly, semi-annual and yearly checks and tasks.
- .2 Describe lubrication and maintenance procedure for equipment components such as bearings, drives, motors, and filters. Include recommended lubricants.
- .3 Compile this information for each typical piece of equipment.
- .4 Provide a belt schedule.

.10 Tab 1.5 List of Equipment Suppliers and Sub-contractors:
- .1 Provide complete list of Equipment Suppliers and Sub-contractors, including address and telephone number.
- .2 Outline procedures for purchasing parts and equipment.
- .3 Provide a parts list and repair manual for each piece of complete equipment specified.

.11 Tab Certification (2.0, 2.1, etc.) Include copies of:
- .1 Pre-operational cleaning reports and chemical treatment as specified in Section 15475.
- .2 Hydrostatic and air tests performed on piping systems.
- .3 Equipment alignment certificates.
- .4 Balancing reports for air and water systems.
- .5 Valve tag identification. Schedule including location, service and normal position.
- .6 Pipe colour code.
- .7 Inspection approval certificates for plumbing and gas systems.
- .8 Inspection approval certificates for all air heating and ventilation systems.
- .9 Start-up reports of equipment
- .10 Guarantee certificate.

.12 Tab Shop Drawings (3.0, 3.1, etc.):
- .1 Include copy of all reviewed only Shop Drawings.
- .2 Include reduced record control drawings (8½ x 11 or 11 x 14 fold out).

.13 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 and Maintenance 3.0 - 3.17 - Yellow. Plastic tabs with typed insertions will not be accepted.

.14 A sample of an acceptable manual may be viewed in the consultant's office.

12. RECORD DRAWINGS

.1 Submit record drawings identifying location of fire dampers, major control lines, access doors, tagged valves and actual room names or numbers and as follows in accordance with Section 1300.

.2 The Contractor shall be responsible for and keep one set of white prints, including revision drawings, in job site office. Backfilling will not be allowed until underground service dimensions are marked on plans. Set of white prints shall be maintained in constant up-to-date condition by each trade (as-built conditions marked in red pencil). The 1 white set of prints will be provided to the contractor by the Consultant.

.3 The "Record Drawings shall include, but not be limited to, the following changes and shall be recorded daily.

.4 Size, location, arrangement, route and extent of ductwork, piping, conduit, terminal units, equipment, fixtures, cleanouts, valves, rough-in, etc., above and below grade inside the building, including dimensioned locations of buried piping from building walls.

.5 All services located below ground level and in or below a building slab.

.6 All valve stations, coils, dampers and ductwork not easily accessible.

.7 All changes which affect the operation of the mechanical system.

.8 Location, tagging and numbering of all valves except individual plumbing fixtures or equipment isolation valves.

.9 The as-built daily marked-up prints and mylar sepias shall conform to the standards of the contract drawings and shall include all details from revision drawings, supplementary drawings, change orders, addenda and site revisions, etc.

.10 Each white print drawing sheet and mylar sepia shall be marked: "We hereby certify that these drawings represent the building, as built" with signatures immediately below of authorized personnel of this Sub-Contractor.

.11 At end of construction, all of the above changes shall be transferred by the Consultant at the Contractor's cost to a set of "Autocad" system disks containing the mechanical drawings and revised accordingly. These disks shall then be used to provide one set of mylar sepias. Sepias and prints shall all be handed over by the Sub-Contractor to the Owner. The revised "Autocad" disks shall be retained by the Consultant.

13. PAINTING AND IDENTIFICATION

.1 Clean all exposed bare metal surfaces supplied by the Mechanical and Plumbing Trade by removing all dirt, dust, grease and millscale.

.2 Repaint all marred factory finished equipment, which is not scheduled to be repainted, to match the original factory finish.

.3 Natural gas and fire protection piping shall be painted over their entire lengths throughout all exposed areas and in the mechanical room as follows:

.1 Gas: Yellow - C.G.S.B. 505-101

.2 Fire: Red - C.G.S.B. 509-102

.4 Paint

.1 Painting other than identification and prime coating shall be done by the painting trade.

.5 Colours

.1 Colours of pipe markers and paint are to conform to the following C.G.S.B. code:

Yellow	505-101
Green	503-107
Blue	202-101
Red	509-102
White	513-101

.6 Pipe Markers and Direction Arrows

.1 This piping identification system leads itself to commercially available pipe markers having standard sizes of lettering and colours. Standard colours designate classes of materials as follows, and are consistent with those specified by the CSA and the USASI.

Yellow	Dangerous Materials
Blue	Protective Materials
Green	Safe Materials
Red	Fire Protection Equipment

.2 The pipe markers and direction arrows shall be applied in accordance with the manufacturer's instructions, and shall be applied by the mechanical trade.

.3 Pipe markers and direction arrows shall be made of a vinyl film material that becomes permanent after curing in place for 24 hours.

.4 Pipe markers and direction arrows shall be suitable for continuous operating temperatures between -40° and 120°F.

.5 Pipe marker letters are to be 50mm high for pipes 75mm and larger outside diameter (including insulation) and not less than 18mm high for smaller diameters.

.6 Pipe marker direction arrows are to be 150mm long by 50mm wide for pipes 75mm and larger outside diameters (including insulation) and 100mm long by 18mm wide for smaller diameters. Mini-markers are to be used for very small diameter pipes.

.7 When it is necessary to use lettering that is not factory printed, the lettering shall be done to sign painting standards on black pipe markers.

.7 Location of Pipe Markers and Direction Arrows

.1 Pipe marker and direction arrow shall be placed side by side in the bottom quarter of the pipe to be identified.

.2 Adjacent to all major changes in direction.

.3 At least once in each room that the pipe passes through.

.4 Where piping passes through walls, partitions, or floors, identify piping on both sides of the section.

.5 Where piping is concealed in a chase, shaft, gallery or other confined space then identify the piping at the points of entry and leaving, and at each access opening.

.6 At the beginning and end points of each run; and, at each piece of equipment in each run.

.7 On long straight runs of horizontal piping in open areas of buildings, galleries, or tunnels, locate markers and arrows so that at least one identification is clearly visible from any point of view in operating areas or walking aisles. In no case shall the distance between markers (and arrows) be more than 7.6 meters.

.8 Locate markers and arrows at all major valves in a system at a point as close as is practical to the upstream side of the valve.

.8 Equipment and Ductwork

.1 Each piece of equipment shall be identified by stencilled lettering at least 25 mm high and shall be governed by the size of the equipment.

.2 An identification logic should be developed and followed consistently throughout the project. Some acceptable examples are:

Supply Fan: designate as SF1, etc.
Exhaust Fan: designate as EF1, etc.
Chilled Water Pump: designate as CHWP, etc.

.3 The nomenclature for identification of equipment shall be consistent with the designations in the plans and specifications.

.4 Ductwork runs in mechanical rooms shall be lettered in accordance with 1, 2 and 3 above.

.9 Ceiling Access Panel Identification

The location of terminal units, valves, etc. above ceiling panels shall have their location identified by means of a coloured tack or data dot as follows:

Avery Dot Colour	Valve Access	Other Access
Red	Fire Protection (including drains)	Fire damper and life safety devices
Yellow		Cleaning and service access (plumbing & HVAC)
Green	Heating/chilled, DCW, DHW Shut-off	
Blue		Damper (backdraft, balance and control)
Black	Control valve	All other control devices

.10 Duct Access Panel Identification

Identify the function of duct access panels by the following schedule:

	Symbol
Cleaning & service	C.A.
Controls (including sensors	C

Dampers (backdraft, balance and control)	D
Fire Dampers	F,D.
Smoke Dampers	S.D.

.11 Valve Tags

.1 All valves, except convector hand valves and individual plumbing fixture stop valves, shall be provided with 50mm x 30mm brass tags with stamped numbers, secured by chains to the valve concerned. Numbers shall be prefixed by the letter "P" or the letter "H" indicating that the valve is on plumbing or heating service.

.2 Each trade shall prepare a list detailing the valves, location; normal position, and purpose served. Trades shall co-operate in preparing a white print chart showing location of all valves.

.3 Chart lists shall be approved by the Architect, subsequent to which one copy of each shall be provided in a non-glare glazed frame, mounted to the Architect's direction, and one copy of each shall be inserted in each Maintenance Manual.

14. TEMPORARY HEAT

.1 Note Section 01500.

.2 Do not use the permanent system for temporary heating purposes without written permission from the Owner/Consultant.

.3 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection. Clean heating and cooling coils.

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

.5 Operate heating system under conditions which ensure no temporary or permanent damage. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate systems only with cleaned piping systems and treated water as specified.

.6 Where air systems are used during temporary heating, provide filter media on return and exhaust air outlets. Clean duct systems which have become dirty.

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

.8 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals. All bearings for equipment used shall be checked, re-greased, oiled and cleaned to bring it back to an "As-New" condition.

15. EQUIPMENT PROTECTION AND CLEAN-UP

.1 Protect equipment and material in storage on site 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 All mechanical equipment stored on site shall be kept in a dry, heated and ventilated storage area.

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

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

.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.

.7 Provide, install and maintain 30% efficient temporary filters to return and exhaust air openings from ceiling spaces to prevent air born dust from entering ducts, plenums and coils. Install filters to return air grilles when fans are operated and building is not at a clean condition.

16. TEMPORARY OR TRIAL USAGE

.1 Temporary or trial usage by the Owner of mechanical equipment supplied under contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

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

17. ELECTRICAL MOTORS

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors to CEMA and CSA standards for hard, continuous service, designed to limit temperature rise to 40°C for open housing and 50°C for drip proof housing, and operate 1200 or 1800 r/min unless otherwise specified. Do not use air over ratings.

.3 Motors shall have ball or roller type bearings with grease lubrication fittings.

.4 All belt-driven devices shall have the motors mounted on adjustable bases with adjusting screws so that proper belt tension can be obtained.

.5 Where equipment has been specified in Division 15 to be complete with starters, disconnects and/or control panels, this contractor shall provide any required control wiring and conduit between the equipment and the above items. All power wiring to the units and between devices shall be by Division 16 Electrical.

.6 Refer to electrical specification for voltage, phase and cycle.

.7 Motors of 15 kW and greater shall have capacitor and thermistor over heat protection. Motor noise criteria shall not exceed NC-60.

.8 Refer to Section 15660 - Extra High Efficiency Motors.

.9 Contractor to submit an electrical motor list for co-ordination with the electrical contractor prior to the installation of any mechanical equipment requiring electrical connection.

18. ACCESS DOORS AND PANELS

.1 Provide access panels required in building construction for access to any concealed mechanical equipment which, in with the Consultant's opinion, requires maintenance or adjustment.

.2 Such panels shall be manufactured, panels, with fastening devices, appropriate to the construction involved, subject to the Consultant's approval.

19. ACCESS OF EQUIPMENT

.1 Make all arrangements to ensure that access into the building is available for all mechanical equipment. Do all hoisting and rigging into place of all specified equipment and be responsible for any damages incurred therefrom.

20. LIABILITY

.1 Assume full responsibility for laying out the work and for any damage caused to the Owner or other Sub-Contractors by improper location, or carrying out of the work.

.2 Be responsible for prompt installation of this work in advance of concrete pouring or similar work. Provide and set sleeves where required. Should any cutting or repairing of either unfinished or finished work be required, this Sub-Contractor shall direct the particular Sub-Contractor whose work is involved to do such cutting and repairing without expense to the Owner. Before being undertaken, such work shall be laid out for the Consultant's review.

.3 Examine the site and the local conditions affecting work under this Contract. Examine carefully the mechanical, electrical, structural and architectural drawings and confirm that the work under this Sub-Contract can be satisfactorily carried out without changes to the building as shown on these plans. Before commencing the work, examine the work of the other Trades and report at once any defect of interference affecting the work or warranties of this section. No extras will be subsequently allowed for such error, omission or oversight on the thorough inspection of the grounds, building, conditions, etc.

.4 Arrange work in co-operation with other trades in the building in such a manner as not to interfere with other work being carried on in the building and places where other pipes, ducts, conduits, cable and equipment are to be installed along with the pipes and ducts pertaining to this trade. Co-operate with the other trades to get all the pipes, ducts, conduit, etc., installed to the best advantage. When open web structural joists are used, obtain structural shop drawings to ensure adequate space is available for installation of pipes and ductwork.

.5 Where any pipes, ducts and equipment supplied by this Sub-trade must be built into the work of other trades such as masonry, structural, or plastering, be responsible for supplying the equipment to be built in or for measurements to allow the necessary openings to be left. All pipes and ducts which are to be

concealed shall be installed neatly and close to the building structure so that the necessary furring can be kept as small as possible. Any pipes, ducts, or other work which are not, in the opinion of the Consultant, installed as they should be, shall be taken out and replaced without cost to the Owner.

.6 Protect finished and unfinished work from damage due to the carrying out of his work, giving special attention to the protection of building vapour barriers, waterproof membranes, etc. Cover floors and other parts of the building with tarpaulins, etc., and repair all damage to the satisfaction of the owner and the Consultant. During freezing weather, protect all his materials in such a manner that no harm can be done to installations already in place and/or to materials and equipment on the job.

.7 Be responsible for the condition of all materials and equipment supplied and for providing all necessary protection for same.

.8 Be responsible for the protection and maintenance of the work of this Section until the work has been completed and accepted by the Owner for storing materials inside and out of the way, and for cleaning up all refuse caused by this work to the Consultant's approval.

.9 On completion of the work, all tools and surplus and waste materials shall be removed and the work left in a clean and perfect condition.

21. LIABILITY INSURANCE

.1 This Sub-Contractor shall maintain such insurance as will fully protect both the Owner and himself from any and all claims, all as noted within the General Conditions as amended under Supplementary Conditions.

22. GUARANTEE WARRANTY

.1 This Sub-Contractor shall furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period of one (1) year from the date of substantial performance, which shall include one (1) complete summer and one (1) complete winter of uninterrupted operation. Warranty shall include any part of equipment, units or structures furnished hereunder that show defects in the works under normal operating conditions and/or for the purpose of which they were intended.

.2 The above parties further agree that they will at their own expense promptly investigate any mechanical or control malfunction, and repair or replace all such defective work, and all other damages thereby which becomes defective during the time of the guaranty-warranty.

23. HOISTS AND SCAFFOLDS

.1 Provide all necessary interior movable or roller scaffolds, platforms, lifts and ladders for the installation of the mechanical work.

24. PIPE CHASES AND DUCT SHAFTS

.1 Unless otherwise indicated, conceal piping and ductwork in the construction of the walls and ceilings, and in pipe chases, duct shafts and furring. If it is

necessary to move the location of pipes and ducts from those indicated and provided, consult the Consultant for review before installation of this work.

25. SUBSTANTIAL PERFORMANCE INSPECTION

.1 Prior to the Contractor requesting an inspection for substantial performance all the following items must be provided to permit beneficial use by the Owner.

- .1 Comply with requirements in Section 01300 and 01700.
- .2 Maintenance and Operating Manuals to be submitted and approved.
- .3 Record drawings.
- .4 Balancing reports (Air and water.)
- .5 All motor name plate ratings and actual operating amps and voltages.
- .6 All systems shall be certified in writing by the Contractor as complete and fully operational.
- .7 Instructions to the Owner's operating personnel shall be provided in accordance with the specifications. A signed statement to this effect, countersigned by the Owner, shall be submitted to the Consultant.
- .8 A complete list of items which the Contractor has not finished, or are deficient shall be provided. If, in the opinion of the Consultant, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.
- .9 The Contractor shall be fully responsible for obtaining all necessary data from Sub-trades and suppliers and for presenting this data in an acceptable format for the approval by the Consultant.

.2 The project close-out requirements are specifically listed in each section of this specification. The following is a summary of those requirements. Refer to detailed specifications in each section for further, detailed requirements. Items designated with an asterisk are required to be submitted one week prior to required date of occupancy.

- .1 Controls
  - .1 Controls system completion report (check sheets).
  - .2 As built control brochure.
  - .3 Control training signed off by owner.(Indicate dates of training in letter and attendance.)
  - .4 List of control manuals and documents turned over.
  - .5 Printed copy of control program and database. Printed to disk in word format acceptable.
  - .6 Disc of control system database.
  - .7 Calibration report for refrigeration, and CO sensors.
- .2 Heating/Cooling
  - .1 Boiler Inspection Branch. Gas fired appliances/gas line/pressure piping.
  - .2 Registration certificates for all pressure vessels.
  - .3 Pressure test reports for heating, chilled and refrigeration lines.
  - .4 Vibration isolation report.
  - .5 Valve tag chart for heating.
  - .6 As built drawings.
  - .7 Flushing and cleaning of piping report.
- .3 Miscellaneous
  - .1 Dot identification schedule used for ceilings.
  - .2 Demonstration to owner signed off by owner.
  - .3 List of incomplete or deficient work prepared by each sub trade.
  - .4 Contractor's Letter of Guarantee
  - .5 List of spare parts signed off by owner.

.4 Plumbing
- .1 Final plumbing acceptance inspection report from municipality.
- .2 Valve tag chart for plumbing system.
- .3 Pressure test reports for sanitary, storm and domestic water.
- .4 Back flow prevention test reports.
- .5 As built documents.
- .6 O&M information.
- .7 Final gas inspection acceptance inspection.
- .8 Inside water service chlorination report as per 15475

.5 Sprinkler
- .1 Final sprinkler acceptance inspection report from municipality.
- .2 Valve tag chart and low point drains.
- .3 Back flow prevention test reports.
- .4 As built documents.
- .5 O&M information. Spare sprinklers, cabinet and wrench.

.6 Ventilation
- .1 Fire damper test report letter and schedule.
- .2 As built drawings.

.7 Manufacture start up and other reports
- .1 Air and Water Balance
- .2 Heating, chilled and condenser chemical treatment.

All life safety systems must be operational and tested and demonstrated to KEL prior to occupancy. This includes items such as fire pump, sprinklers, stair pressurisation fans, smoke exhaust system, parkade CO system exhaust.

26. LAWS, NOTICES, PERMITS AND FEES

.1 Give all necessary notices, obtain all necessary permits and pay all fees in order that the work hereinafter specified may be carried out. Furnish all certificates necessary to evidence that the work installed conforms with all applicable laws and regulations of all authorities having jurisdiction.

.2 All work shall be in accordance with the regulations of the following authoritative bodies, the codes in effect at the time of tender, and any other authorities having jurisdiction:
- .1 Fire Marshall
- .2 Canadian Electrical Code
- .3 Local Building By-Laws
- .4 Alberta Building Code 1997
- .5 Alberta Fire Code 1997
- .6 Worker's Compensation Board
- .7 Canadian Standards Association
- .8 Pollution Control Board
- .9 Refrigeration Code and C.S.A. Codes governing refrigeration plants
- .10 Canadian Gas Code B-149.1
- .11 1990 National Building Code of Canada
- .12 Boiler and Pressure Vessel Act.
- .13 National Fire Protection Association
- .14 National Plumbing Code
- .15 Underwriters' Laboratories of Canada

27. DEMONSTRATION AND INSTRUCTION TO OWNER

.1 Demonstrate to and instruct the representative designated by the Owner on the complete systems operating and maintenance procedures using the assistance of specialist sub-trades and manufacturer's representatives.

.2 Submit a program for approval 14 days prior to substantial completion. When approval is obtained from the Consultant, arrange an acceptable time with the Consultant for the execution. Allow a period of five (5) days. During this period, the following systems shall be demonstrated in regards to performance and safety features (to the fullest):

.1 Air Handling Systems (Supply, Return, Exhaust)
.2 Heating Systems (H.W. Heating, D.H.W.S.)
.3 Chilled Water System (All Ancillaries)
.4 Controls System
.5 Fire Protection and Plumbing Systems
.6 Refrigeration

.3 Obtain a signed statement from the Owner certifying that the demonstration and instructions have been given to his satisfaction.

.4 Provide a minimum of three (3) monthly, one day visits to the building to check that building operators are operating and maintaining mechanical systems in proper manner and keeping schedules up to date. Forward complete written report to the Consultant after each visit.

28. INSPECTION

.1 The Consultant or his representative shall inspect all work prior to it being concealed. All work shall be approved by all authorities having jurisdiction. All piping below ground must be approved prior to covering. All openings shall be fire stopped in rated walls and floors. Sealing shall be approved prior to covering.

.2 The Consultant requires 48 hours notification prior to scheduling inspections.

29. TEMPORARY FACILITIES

.1 See Section 01500.

.2 Provide all temporary buildings and workshops that may be required for workmen, for this section on-the-site operations, storage of materials and sewer connected water closets for the use of workmen. Provide, near the site and keep open at all times during construction on the project, an office for his own use where all notices and instructions from the Consultant will be received and acknowledged by himself or his authorized representative. Accommodations shall confirm in appearance to the General Contractor's.

30. CONTRACT PRICE BREAKDOWN

Mechanical Contract Breakdown

		Cost	Name of Contractor
1.	Heating	$	
2.	Plumbing	$	
3.	Sheet Metal	$	
4.	Sprinklers	$	
5.	Insulation	$	
6.	Controls	$	
	TOTAL	$	

.1 Within 7 days of contract award, provide Keen Engineering with a standard 3 page breakdown of suppliers/costs for the entire project. This will be used for progress claims throughout the project and should be broken down into phases of the project where appropriate and site costs.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Test heating water piping.

.2 Test chilled water piping.

.3 Test domestic water piping.

.4 Test sanitary sewer piping.

.5 Test storm sewer piping.

.6 Test natural gas piping.

.7 Test fuel oil piping.

.8 Test standpipe system piping.

.9 Test sprinkler system piping.

.10 Test refrigerant piping.

.11 Test low velocity ductwork.

.12 Test fire dampers and fire/smoke dampers.

.13 Backflow Preventor Devices

1.2 Quality Assurance

.1 Test equipment and material required by specification or by authorities having jurisdiction to demonstrate proper and safe operation.

.2 Test procedures shall be in accordance with applicable portions of ASME, ASHRAE, SMACNA and other recognized test codes. Test shall be in accordance with all applicable codes.

.3 Piping, fixtures or equipment shall not be concealed or covered until inspected by the Consultant. Provide ample written notice to the Consultant before tests.

1.3 Submittals

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

.2 Upon completion of mechanical installation, perform tests as specified. Provide certification of tests with detailed data as required. Itemize each test as to time of testing and personnel responsible. Include in Operating and Maintenance Manuals.

1.4 Liability

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

2. PRODUCTS

.1 The gauges used during testing shall have been calibrated within 6 months of tests. Produce calibration certificates upon request of the consultant. Provide information on gauge accuracy.

3. EXECUTION

3.1 Pressure Tests

.1 Provide equipment acceptable to materials and labour for tests and pay expenses. Use test instruments by approved laboratory or manufacturer acceptable to the Consultant. Furnish certificate showing degree of accuracy. Install permanent gauges and thermometers that are to be used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out hydraulic tests for 8 hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and retest.

.3 Heating water piping: Test minimum 1½ times maximum working pressure or 1030 kPa water pressure.

.4 Chilled and condenser water piping: Test to minimum of 1½ times maximum working pressure or 1030 kPa water pressure.

.5 Domestic water piping: Test to 1400 kPa water pressure measured throughout for 8 hours or one and one half times the working pressure whichever is greater. Use an air test during freezing conditions.

.6 Storm and sanitary drainage system: Test by filling with water to produce water pressure of 30 kPa minimum and 75 kPa maximum for 8 hours. Check for proper grade and obstruction by ball test. Use an air test during freezing conditions.

.7 Gas piping: Test as required by authorities having jurisdiction.

.8 Standpipe system: Test 2070 kPa water pressure at the valve and to NFPA standard 14 requirements.

.9 Sprinkler system: Test as required by authorities having jurisdiction and NFPA standard 13 requirements min 1380 kPa.

.10 Refrigerant piping: Test with nitrogen to 2070 kPa on high pressure side and 1030 kPa on low side.

.11 Low pressure ducts: Test for tightness such that leakage is inaudible and not detectable by feel.

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

.13 Fire Dampers and Fire/Smoke Dampers: Demonstrate the operation and access to each damper. Reset each damper.

.14 Test fuel oil piping at a negative pressure of 80 kPa for 24 hours.

.15 Should tests indicate defective work or variance with specified requirements make changes immediately to correct the defect. 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.

3.2 Performance Tests

.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, adjustments, and replacements requested as tests may indicate prior to operating tests.

.2 Provide factory approved start-up for packaged equipment and provide report.

.3 Make operating tests for minimum of 5 days during heating season and cooling season of first year of operation, and at times when directed, for proper settings of controls under peak load conditions.

.4 Conduct final operating tests in presence of the Consultant. Vary loads to illustrate start-up and shut down, sequence, and simulate emergency conditions for safety shut-downs, with automatic and manual reset. Repair and test defects until satisfactory. Make final adjustments to suit exact building conditions.

.5 Provide services of one job mechanic, ladders, tools, and associated equipment required to assist the Consultant in final test.

.6 Lubricate bearings, adjust and/or replace and set direct and "V" belt drives for proper alignment and tension.

.7 Calibrate and adjust thermostats, thermometers, gauges, linkage and dampers. Control valves shall operate freely.

.8 Operate and test motors and speed switches for correct wiring and sequences. Check overload heaters in motor starters.

.9 Replace and clean filters. Clean fan wheels and coils.

.10 Remove and clean strainers.

.11 Fasten loose and rattling pieces of equipment. Unit heaters, pumps and other equipment shall operate quietly.

.12 Provide flushing connections on all standpipe and sprinkler systems.

.13 Eliminate any noise and vibration if such is not acceptable to the Consultant and Owner at no expense to the Owner.

.14 Sample packing of sleeves to prevent noise and fire/smoke transmission must be approved under test.

.15 Selected packing of sleeves shall be dismantled for review and repacked.

.16 Field test installed backflow preventor devices.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Balance, adjust and test air systems and equipment, and submit reports as specified.

.2 Balance, adjust and test water systems and equipment, and submit reports in SI Units.

.3 Balance domestic hot water recirculation systems and submit reports as specified.

1.2 Quality Assurance

.1 Testing and balancing shall be performed by an approved balancing specialty firm that specializes in this type of work. The approved agency shall be a certified member of AABC or NEBB,

.2 Prior to undertaking the testing and balancing tasks, provide a listing of the instruments used including make, model, serial no. range, and calibration date. All instruments must have been calibrated within 6 months of date of use. Reported balancing and testing data shall include all of the data indicated in the Associated Air Balance Council Manual (Chapter 26).

.3 Provide extended warranty of 90 days after completion of test and balance work. During this period the Consultant may request re-check, or resetting of outlets or fans as listed in test reports. Provide technicians and instruments as required.

.4 Begin testing and balancing after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of testing and balancing.

.5 This agency shall remove and re-install ceiling tile to provide access to ductwork and piping. The balancing Contractor will make good any damage or soiling caused by his forces.

.6 Carry out testing, adjusting and demonstrating of work prior to takeover by the owners.

.7 Have all work performed solely by persons with proven ability and thoroughly versed in the type of testing and balancing. Submit names, complete with experience, record and references for review of the Consultant prior to work being carried out.

.8 Witnessing of all tests by the Consultant and/or owner shall be at their option. Advise the consultant and/or owner of the time and location of tests.

.9 Test records of all manufactured equipment shall be complete with a manufacturer's affidavit.

.10 Have all records signed for accuracy by all witnesses and forward to consultant for review.

.11 Bind a complete set of test records in each Owner's manual issued, and note those records for which tests have been witnessed by Authorities having jurisdiction.

1.3 Balancing Agenda

.1 Submit balancing agenda for approval within thirty (30) days of Award of Contract. Start balancing work after agenda has been approved. Include descriptive data, procedure data, and sample forms in agenda.

.2 Prior to commencement of balancing, review with the Consultant method and instruments to be used in balancing. Discussion shall include descriptive data, procedures data, and sample forms.

.3 Provide a general description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed, Select points for proposed sound measurements.

.4 Provide 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.

.5 Provide sample forms showing application of procedures to typical systems as per AABC's test sheets.

1.4 Balance Report

.1 Submit four (4) copies of reports described to the Consultant prior to final acceptance of project.

.2 Provide reports in separate hard cover 3-ring binder manuals, separate from maintenance manuals, complete with index page and indexing tabs and cover identification at front and side.

.3 Stamp reports by a Registered Professional Engineer or Certified Technologist in this Province certifying adherence to agenda, calculation procedures, and final summaries.

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

1.5 System Data

.1 Submit report forms to the Consultant for review. Additional information may be required.

2. PRODUCTS

2.1 Instruments

.1 Use accurate instruments for measurement. The agency shall have the instruments necessary to complete the work. The agency shall, when called upon to do so, prove out the correct calibration of the instruments used, or alternatively produce a calibration report from a recognized testing laboratory. All instruments used on the project shall have been re-calibrated within the previous six months.

.2 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 Procedures

.1 Balance air quantities for supply, return, exhaust and transfer systems to the design requirements and position vane outlets to give the required pattern. The balancing shall be achieved by the use of dampers located in the branch ducts.

.2 Permanently mark settings on valves, splitters, dampers and other adjustment devices.

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

.4 At final inspection, re-check random selections of data recorded in report. Re-check points or areas as selected and witnessed by the Consultant.

.5 Do monitoring work after take over by the Owner. Check and adjust systems approximately six (6) months after final acceptance and submit reports.

.6 The agency shall check for malfunctions during balancing and where these arise the agency shall advise so that the appropriate trade or supplier can be informed.

.7 It is not intended that this work shall, in any way, replace normal factory start-up service for such equipment as air handling units and chiller plant, or relieve the Contractor or sub-trades of their responsibility for providing a first-class installation in satisfactory work order.

3.2 Air System Procedure

.1 Balance air quantities, supply, return, exhaust systems to not less than design and not more than 110% of the design requirement. The balance shall be achieved by the use of dampers located in the branch ducts. Where more than one diffuser (or register) is supplied from the same branch duct, then "fine-tuning" dampers are to be provided by Division 15 at each diffuser (or register). The "fine-tuning" dampers shall be in addition to the branch damper.

.2 Adjust fan speed or blade angle where this is adjustable, to produce design volume. Where required adjustment is beyond the range of the sheave supplied. The contractor shall, together with the equipment supplier, install a sheave of the required size. This agency shall rebalance as necessary to obtain design requirements.

.3 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross-sectional area of duct.

.4 Measure air quantities at each air inlet and outlet.

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

.6 Fan balancing shall be measured with the filters artificially loaded to 50% of pressure drop range at full air flow. List these filter pressure drops. Measure and record fan motor amperage of balanced fan with clean filters and full air flow.

.7 Seal all holes used for flow and pressure measurements after testing with approved plugs or caps. An air tight seal must be maintained.

.8 Verify the operation of all:
- .1 Thermostats operating valves or boxes.
- .2 On/off switches on equipment
- .3 Interlocks between equipment.

3.3 Water System Procedures

.1 Upon completion of water piping systems and after hydrostatic testing and cleaning, each piping system shall be balanced.

.2 A portable differential pressure meter and/or temperature differential shall be used for determination of flow or each of the major systems.

.3 Set balance valves and balance fittings to obtain uniform pressure and/or temperature differences across terminal heating/cooling elements and coils, acknowledging the difference design pressure and/or temperature drop/rises.

.4 Trim pump impellers to match pump performance to system characteristics rather than artificially increase system pressure drops to match pump characteristics. Costs incurred will be considered as an extra.

.5 Mark the final balance position on all balance valves and balance fittings.

.6 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

.7 Where pump capacity available is less than total flow requirements or individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.

.8 The Contractor shall co-operate with the Balancing Contractor and provide any assistance required. He shall add balancing valves, provide access, etc., as requested to produce the required system balance.

.9 Report the following:
- .1 Date of test or retest
- .2 Name of building and address
- .3 Tester's name
- .4 Outdoor air temperature
- .5 Main supply and return water/glycol temperature across each pump circuit
- .6 Operating performance of each pump and associated motor
- .7 Entering and leaving water/glycol temperature at each terminal heating/cooling element, coil and heat exchanger
- .8 Flow rates at measuring devices
- .9 Suction pressure, delivery pressure and differential head across circulating pumps. Indicate on pump curves.

.10 Document all methods of measurements
.11 Maximum sheet size for drawings and schedules to be 275 mm x 425 mm.

.10 The domestic hot water recirculation system shall be balanced using memory stop type balancing cocks. The following information shall be provided:
.1 location in as-built drawings of all balancing cocks
.2 valves shall be tagged as are all other valves and the set position of the balancing valves shall be identified on the valve chart
.3 the as-built drawings shall have the valve tag number shown

END OF SECTION

1. GENERAL

1.1 Scope

.1 Includes piping within, buried beneath and to beyond the building as follows:
- .1 Sanitary drainage and vent.
- .2 Storm sewer.
- .3 Footing drains.
- .4 Natural gas.
- .5 Hot water heating.
- .6 Domestic water.
- .7 Fire protection.
- .8 Refrigerant.
- .9 Fuel oil.
- .10 Chilled water.
- .11 Equipment relief piping.
- .12 Refer to Section 15580 for Firestopping.

1.2 Welding

.1 Welding materials and labour must conform to ASME Code and the Provincial requirements. Field welding in general shall be in accordance with Current Edition of ASME/ANSI B31.1 or B31.9.

.2 Use B welders fully qualified and Licensed by Provincial Authorities.

.3 Use qualified pressure welders for contained pressures in excess of 100 kPa.

1.3 Quality Assurance

.1 Gas piping: National Standard of Canada CAN/CGA-B149.1-M95, Natural Gas installation code.

.2 Oil piping: CAN/CSA B139-M1, installation code for oil burning equipment, NFPA-31 "Oil Burning Equipment

.3 Automatic Sprinkler system piping: NFPA No. 13, Standard for the Installation of Sprinkler Systems and NFPA No. 20 standard for the installation of centrifugal fire pumps.

.4 Standpipe and hose system piping: NFPA No. 14, Standard for the Installation of Standpipe and Hose Systems.

.5 Domestic water, drainage, and vent piping: (Provincial Plumbing Code, National Plumbing Code of Canada 1995.)

.6 Copper pipe, direct connections: UL approval; brazing in accordance with Copper Development Association Copper Tube Handbook.

.7 All PVC piping shall be CSA approved and installed to the Provincial and National Plumbing Code and CSA references and requirements.

.8 Lead free solder to be used on the potable water system.

.9 Piping for fire protection systems shall be ULC and F.M. approved.

.10 Type K Copper pipe must be certified to be in accordance with ASTM B88.

.11 Heating water piping, and chilled water to ASME/ANSI B31.9 and CSA B51.

2. PRODUCTS

2.1 Pipe

SERVICE		MATERIAL
.1	Natural Gas, Vents Emergency generator exhaust.	Steel Schedule. 40 black, 10 mm wall for sizes 300 mm and larger. Show yellow jacket on all buried steel piping and joints.
.2	Hot Water Heating to 121 °C, Chilled Water	Steel Schedule. 40 black, 10 mm wall for sizes 300 mm and larger. Type "L" hard copper, type "K" soft copper buried. Schedule 80 for condenser water.
.3	Equipment Drains and Overflows	Steel Schedule. 40 galvanized, copper type K.
.4	Refrigerant	ACR Copper, Grade 2, type K.
.5	Sanitary Drainage and Vent unburied	Type "DWV" copper, or Cast Iron.
.6	Sanitary Drainage and Vent buried	Cast Iron, ABS (max. 212°F), PVC(max. 140°F), type "M" or "DWV" copper
.7	Storm Drainage, buried	Cast Iron c/w S.S. couplings, ABS, PVC.
.8	Footing Drainage	PVC SDR 35 perforated. PVC SDR 28 for deep burial and traffic areas.
.9	Storm drainage, unburied	Cast iron or copper, type K
.10	Domestic water, unburied	Type L hard copper or cement lined ductile iron
.11	Domestic water or combined fire/domestic water buried	Type K soft copper, PVC Ringtite, cement lined ductile iron. Rod to manufacturer's requirements.
.12	Fire Protection	Steel Schedule. 40 black, to NFPA requirements, show yellow jacket on all under ground piping and joints.
.13	Sprinkler	Steel at appropriate schedule or Type K copper tube to NFPA requirements.
.14	Equipment Relief Piping	Steel Schedule. 40 black.
.15	Fuel oil piping	Type K hard copper schedule 40 steel, fibreglass, nylon.

2.2 Fittings

FITTINGS		MATERIAL	JOINT
.1	Hot Water heating to 121°C	Malleable iron 1030 kPa banded. Steel same thickness as pipe. Wrought copper, cast bronze	Threaded Welded 95-5 solder (flare)
.2	Chilled water	Malleable iron 1030 kPa banded. Steel same thickness as pipe. Wrought copper, cast bronze malleable iron grooved	Threaded Welded 95-5 solder (flare) grooved mechanical
.3	Natural gas	Malleable iron 1030 kPa banded air-tested, for pipe sizes 50 mm and under pipe sizes over 50mm	Threaded Welded
.4	Refrigerant	Wrought copper. Steel same thickness as pipe for sizes 50 mm and over. Forged brass.	Brazed, copper alloy Brazed, silver alloy
.5	Equipment Drains and Overflows	Malleable iron 1030 kPa banded, galvanized Steel, same thickness as pipe galvanized. Malleable iron grooved galvanized. Wrought solder or cast brass	Threaded Welded Grooved mechanical 50-50 solder
.6	Sanitary drainage and vent, unburied	Wrought copper. Cast iron	50-50 solder Mechanical joint with full stainless steel band and clamps.
.7	Sanitary Drainage and Vent, buried	Wrought copper Cast iron ABS, PVC	Silvabrite solder (95.5% tin, 4% copper and 0.5% silver) Mechanical joint with full stainless steel band and clamps Solvent weld or grooved mechanical
.8	Storm drainage, unburied, buried	Cast iron	Mechanical joint with full stainless steel band and clamps

.9	Storm drainage, buried	ABS, PVC	Solvent weld or grooved mechanical
.10	Domestic water, unburied	Wrought copper, bronze or cast iron. Cast ductile iron Ductile iron, cement lined 100 mm & larger	Silvabrite solder (95.5% tin, 4% copper and 0.5% silver). Copper connection Style 606 grooved coupling for sizes 50 mm to 150 mm. Grooved joints, c/w rodding
.11	Domestic water or combined fire/water, buried	Copper PVC Ringtite Ductile iron cement lined	95.5% tin, 4% copper and 0.5% Silvabrite Hub & Spigot Tyton (rodding to manufacturer's requirements)
.12	Fire Protection	Malleable iron or cast iron Malleable iron or steel grooved. Steel, same thickness as pipe.	Screwed or flanged. Grooved mechanical Weld
.13	Emergency generator exhaust pipe	Steel, same thickness as pipe.	Welded.
.14	Fuel oil distribution	Malleable iron 1030 kPa Forged brass fibreglass	Threaded Flared, threaded fibreglass cement weld and bolted coupling
.15	Fuel oil fill, vent and sounding (welded)	Steel same thickness as pipe.	Welded.
.16	Footing Drainage	PVC	Ringtight
.17	Equipment Relief	Malleable iron 1030 kPa Steel same thickness as pipe.	Screwed Welded

.18 Factory fabricated butt weld fittings are required for welded steel pipes.

.19 Long radius elbows are required for steel and cast iron water piping.

.20 Schedule. 40 pipe and fittings shall be Schedule. 40 for pipe up to 250mmø. and STD for 300 mmø. and larger. Sch. 80 pipe and fittings shall be Sch. 80 for pipe up to 200 mmø. and XS for 250 mmø. and larger.

2.3 Unions and Couplings

.1 Size 50 mm and under: 1030 kPa malleable iron, bronze iron ground joints for threaded ferrous piping, air tested unions for gas service, all bronze unions for copper piping.

.2 Size 65 mm and over: 1030 kPa forged steel but weld flanges for ferrous piping, 1030 kPa bronze flanges for copper piping. Gaskets shall be 1.5 mm thick compressed carbon fibre gasketing, Garlock HTC-9850. Gasket for gas service shall be synthetic rubber.

.3 Grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion. Couplings consist of malleable iron steel, or ductile iron housing clamps, C-shaped composition sealing gasket and steel bolts.

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 Entirely avoid air and water pockets in piping. All run-outs shall be installed with swing joints to allow for movement due to expansion and contraction of the main.

.3 All pipes shall be welded with long radius Tube Turn elbows and factory manufactured "T" connections.

.4 Where branch lines are connected to mains two or more sizes larger, the branch may be cut into the pipe. Where branch pipes are welded to mains without the use of "T" connections, torch-cut openings may be cut through, bevelled and filed smooth. Branch pipes must not be cut large enough to permit entry by welding metal and slag within the pipe.

3.2 Connections

.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.

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

.3 Use main sized saddle type branch connections or directly connected preformed branch connections in steel pipe provided that main is at least one size larger than branch up to 150 mm mains and main is at least two sizes larger than branch for 200 mm and larger main. Do not project branch pipes inside the main pipe.

.4 Clamp and rod all buried water and fire protection piping at fittings with 20 mm stainless steel rods. Provide proper anchors and supports.

.5 Use grooved mechanical couplings and mechanical fasteners only in accessible locations. Use galvanized couplings with galvanized pipe. Use welded fittings in lieu of grooved couplings where space is limited.

.6 Make connections to equipment and branch mains with unions.

.7 Provide non-conducting type connections wherever jointing dissimilar metals in systems. Brass adapters and valves are acceptable.

.8 Provide flanges or unions at all connections to equipment, control, valves, etc.

.9 Wrap with multiple thickness of tape or sleeve all buried copper piping.

.10 Make connections to equipment relief connections and pipe to outside to a safe location above roof. Anchor piping and allow for possible expansion.

.11 Do not top off domestic water solder with 50-50 solder.

.12 Joints between glass and other types of materials shall be made with adapter couplings according to the Manufacturer's recommendations.

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 Slope water piping at 0.2% and arrange to drain at low points.

.3 On closed system, equip low points with 20 mm drain valves and hose nipples. Provide, at high points on lines and on equipment connections, collecting chambers and high capacity float operated manual air vents.

.4 Make reductions in water and steam pipe sizes with eccentric reducing fittings installed to provide drainage and venting.

.5 Grade horizontal drainage and vent piping down in direction of flow, 2% minimum.

.6 Provide automatic air vents at all high points, as indicated on the drawings, and as required for the proper operation of the system. Provide a 12mm gate valve ahead of each air vent. Pipe the air vent discharge to the nearest drain using 6 mm hard drawn copper pipe with a label at the drain end. Radiator type vents shall have a 15 mm or line size by 150 mm long collecting chamber. Provide access to all air vents.

.7 Footing Drain Pipe: Install in approved material bed and provide filter cloth unless otherwise indicated. Material bed and filter cloth requirements shall be as required by the Geotechnical Engineer's report. Run at a slope of 25 mm per 6 meter minimum.

.8 Fuel oil piping shall be installed in a continuous run where possible and practical with a minimum of joints underground. Braze all brass copper pipe joints. Suction lines shall have check valves at top of tank. Buried lines shall be laid

straight and true with no dips. Install piping within 50 mm PVC tubing with cemented joints to extend 150 mm inside building. Piping shall be buried a minimum of 1.0 meters. Install swing joints at the tank and at the entry to the building. Dips or traps in suction and return lines are not permitted.

.9 Fuel oil fill and vent line shall be graded to the fuel oil tank or containment sump at 1% with no dips or low points.

3.4 Installation

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected. Also refer to Section 15160 for the provisions of flexible connections in piping systems. Pay particular attention to piping running horizontal across expansion joints and provide adequate expansion and contraction for all such piping.

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

.3 Yellow jacket buried metal gas lines; prime coat and paint lines exposed to outdoors.

.4 All pressure services cap-offs for future shall be provided with valves.

.5 All sanitary waste and storm lines capped-off for future shall be located as low as possible.

.6 Avoid locating water and drain piping over electrical equipment. Where this is unavoidable, provide galvanized drip pans under such pipe and weld piping and fittings. Provide drain and piping from drip pans to satisfactory floor drain.

.7 Avoid piping in exterior walls unless otherwise directed. If required, install this piping protected from the outside by the building insulation and vapour barrier.

.8 Keep piping free from scale and dirt. Protect open pipe ends whenever work is suspended during construction, using temporary plugs, polyethylene or other approved material. Flush out piping systems before making final connections.

.9 Provide accessible valves for all washroom groups hot and cold domestic water services.

.10 Terminate equipment relief piping 2500mm above or at a safe location subject to the review of the Consultant. Provide a secure mesh cap to prevent foreign material entry.

.11 Make connections to all equipment drains, drain pans, and ductwork drains. Pipe to the nearest floor drain or approved connection. Where item being drained is under pressure, provide a deep seal trap.

.12 All cleanouts for footing drains shall be brought up to finished grade. Cleanouts, plugs and covers shall be installed as per cleanout specification. Cleanouts shall be cast into 300mm x 300mm x 100mm concrete pads.

.13 Footing drainage fittings and riser extensions to cleanouts at grade shall be PVC or cast iron pipe and fittings. All fittings shall be long radius type, changes in

direction (90°), shall be made with "Y" fittings and 45° long beams (plug ends of "Y" fittings).

.14 Pipe risers made of steel pipe shall use piping with welded joints and fittings. Riser clamps shall be welded to pipes.

.15 Water and control air piping must not be installed in outside walls or unheated areas.

.16 Minimum pipe and hand valve connections to radiation shall be 20 mm.

.17 Bull head tees shall not be used for converging flows.

.18 The General Contractor shall supply and install concrete thrust blocks on all underground water piping. Thrust blocks shall be installed at all changes of directions, at all tees and at the ends of all mains and branches. The concrete for thrust blocks shall be poured at the fittings against undisturbed, firm, bearing soil. Thrust block sizes and strengths shall be as recommended by the piping manufacturer and suitable for the type of piping material used. Reinforcing shall be #4 bars at 150 mm O.C., each way and on each face. Concrete thrust blocks shall be installed as per the pipe manufacturer's recommendations.

.19 Provide firestopping and smoke seals for piping at penetrations of all fire and smoke rated separations; see Section 15580.

.20 Horizontal pipe runs shall be supported on padded pipe hangers maximum 1 metre on centres.

.21 Vertical risers shall be supported by vertical padded riser clamps to restrict lateral and downward movement. Vertical riser up to 75mm I.D. may be supported at every other floor level, 75mm and greater at every floor level. Unistrut hangers shall not be used.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Fire stopping and smoke seals under Sections 07270 and 15580.

1.2 Scope

.1 Pipe hangers and supports.

.2 Duct hangers and supports.

.3 Flashing for mechanical equipment.

.4 Sleeving for mechanical equipment.

.5 Fire proof sealing of all sleeves through fire separations.

1.3 Reference Standards

.1 Pipe supports shall meet the requirements for ANSI B31.1, Power piping.

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

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

.4 Duct hangers and supports shall follow the recommendations of the SMACNA Duct Manuals.

1.4 General Requirements

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

.2 Install supports of strength and rigidity to suit loading without 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 safety factor of 5 to 1.

.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.

.6 Dielectrically isolate dissimilar metals.

.7 Provide fire retardant pipe, duct sealant where passing through any firewall, slab, etc.

1.5 Alternatives

.1 Obtain approval from Consultant prior to drilling for inserts and supports for piping system.

.2 Obtain approval from the Consultant prior to using percussion type fastening.

.3 Use of existing piping or equipment for hanger support is not permitted.

.4 Use of perforated band iron, wire or chain is not permitted.

2. PRODUCTS

2.1 Inserts

.1 Insert shall be malleable iron case or galvanized steel shell with 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.

.3 Cast-in-place concrete insert shall be galvanized malleable iron or steel Grinnell Fig 281 or Fig 282 or Unistrut.

.4 Drilled concrete insert shall be Hilti Model HSL or HVA.

.5 All inserts shall be ICBO approved. Use only ICBO design load ratings.

2.2 Pipe Hangers and Supports

.1 Hangers: Pipe sizes 12 mm to 40 mm: Adjustable wrought steel ring Grinnell Fig. 97. Oversize cold pipe hangers to fit over insulation. Provide insulation shields.

.2 Hangers: Pipe sizes 50 mm to 100 mm and cold pipe sizes 150 mm over: Adjustable wrought steel clevis Grinnell Fig. 260. Oversize cold pipe hangers to fit over insulation. Provide insulation shields.

.3 Hangers: Hot pipe sizes 150 mm and over: Adjustable steel yoke Grinnell Fig. 181 and cast iron roll Grinnell Fig. 171 with pipe saddle Grinnell Fig. 160 series.

.4 Multiple or trapeze hangers: Steel channels with welded spacers and hanger rods, cast iron and stand for hot pipe sizes 150 mm and over, or Mason SAB.

.5 Wall support: Pipe sizes to 80 mm: Cast iron hook.

.6 Wall support: Pipe sizes 100 mm and over: Welded steel bracket and wrought steel ring, adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm and over.

.7 Vertical Support: Steel riser clamp Grinnell Fig. 261 and 261C.

.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 150 mm and over: Adjustable cast iron roll and stand Grinnell Fig. 274, steel screws and concrete pier or steel support.

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

.11 Provide copper hangers and supports for copper piping (copper cladded hangers are not acceptable).

.12 Beam clamps - Grinnell UFS Fig. 228.

2.3 Hanger Rods

.1 Provide galvanized steel, continuous threaded hanger rods.

2.4 Duct Hanger and Supports

.1 Hangers: Galvanized steel band iron or rolled angle and continuous threaded cadmium plated rods.

.2 Wall Supports: Galvanized steel band iron or fabricated angle bracket.

.3 Vertical Support at Floor: Rolled angle.

.4 Wire duct supports are not permitted.

2.5 FLASHING

.1 Steel Flashing: 0.55 mm galvanized steel.

.2 Flashing: 200 micrometre EPDM

.3 Safes: 200 micrometre EPDM.

.4 Caps: Steel, 0.7 mm thickness minimum 1.6 mm thickness at fire resistance structures.

2.6 Sleeves

.1 Pipes through Floors: Form with 1.2 mm galvanized steel. Extend 25 mm above floor in mechanical rooms and wet floor areas.

.2 Pipes through beams, walls, fire proofing, footings, potentially wet floor: Form with steel pipe or 1.2 mm thickness galvanized steel.

.3 Round ducts: Form sleeves with galvanized steel.

.4 Rectangular Ducts: Form sleeves with galvanized steel.

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

2.7 Finish on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanized or factory primed.

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 plate and nut above slab, in concealed locations.

.5 Provide inserts for above chillers, pumps and sump pumps to permit equipment servicing. Provide an eye bolt.

.6 Inserts shall be installed in accordance with manufacturers recommendations and in no case closer than 7diameters apart.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

NOMINAL PIPE SIZE	DISTANCE BETWEEN SUPPORT	HANGER ROD DIAMETER
12 mm	1.8 m	10 mm
20 mm to 40 mm	1.8 m	10 mm
50 mm	3.0 m	10 mm
65 mm	3.0 m	10 mm
75 mm	3.6 m	13 mm
100 mm	3.6 m	16 mm
150 mm	4.3 m	19 mm
200 mm to 300 mm	4.3 m	22 mm
350 mm to 400 mm	6.1 m	25 mm
450 mm	6.1 m	28 mm

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

.3 Place a hanger within 300 mm of each horizontal elbow, tee, joints, etc.

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

.5 Support horizontal soil pipe near each hub, with 1.5 m 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 Install plastic inserts between steel studs and piping.

.10 Brace drain waste and vent piping with mechanical joints on each side of a change in direction of 90° or more if pipe is more than 300 mm from supporting structure.

.11 Pipe at building expansion joints shall be arranged to provide for building movement as for expansion/contraction.

.12 For beam clamps, extend hanger rod tight to underside of beam with top bolt and washer.

3.3 Duct Hangers and Supports

.1 Refer to SMACNA HVAC Duct Construction Standards First Edition 1985.

.2 Wire supports are not permitted.

.3 Provide supports as per Figs. 4-1 and through 4-9 and tables 4-1 through 4-3.

3.4 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:
- .1 Up to 750 mm wide: 25 x 1.6 mm at 3 m spacing; 10 mm rod;
- .2 790 to 1200 mm wide: 40 x 1.6 mm at 3 m spacing; 13 mm rod;
- .3 Over 1200 mm wide: 40 x 1.6 mm at 2.4 m spacing. 13 mm rod;

.2 Horizontal Duct on Wall Supports Minimum Sizes:
- .1 Up to 450 mm wide: 40 x 1.6 mm or 25 x 25 x 3 mm at 2.4 m spacing;
- .2 480 x 1000 mm wide: 40 x 40 x 3 at 1.2 m spacing.

.3 Vertical Duct on Wall Supports Minimum Sizes:
- .1 At 3.65 m spacing;
- .2 Up to 610 mm wide: 40 x 1.6 mm;
- .3 640 to 900 mm wide: 25 x 25 x 3 mm; 940 to 1500 mm wide: 40 x 40 x 3 mm;
- .4 Over 1520 mm wide: 50 x 50 x 3 mm.

.4 Vertical Duct Floor Supports Minimum Sizes:
- .1 Riveted or screwed to ducts;
- .2 Up to 1520 mm wide: 40 x 40 x 3 mm;
- .3 Over 1520 mm wide: 50 x 50 x 3 mm.

.5 Round Duct Hangers minimum size at 3 m spacing:
- .1 Up to 460 diameter: 25 x 1.66 mm, 6 mm rods
- .2 480 to 900 diameter: 25 x 2.6 mm, 10 mm rods;
- .3 940 to 1290 diameter: Two 25 x 1.6 mm, two 10 mm rods;
- .4 1300 to 2130 diameter: Two 25 x 2.6 mm, two 10 mm rods

3.5 Equipment Bases and Supports

.1 Section 03300 provides for major equipment reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm 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 Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment.

.4 Concrete work provided by Section 03300.

.5 Prime coat steel hangers and supports.

3.6 Flashings

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

.2 Flash, vent and soil pipes projecting 75 mm minimum above finished roof surface with EPDM, 200 mm minimum clear on side with minimum 600 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 EPDM 250 mm clear on sides with minimum 920 x 920 mm sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations 200 mm minimum high. Flash and counterflash with steel, soldered and made waterproofed.

.5 Provide continuous EPDM or neoprene safes for built-up mop sinks, and shower stalls located above finished rooms. Flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

3.7 Sleeves and Escutcheons

.1 Supply and install sleeves in advance of concrete work wherever piping passes through walls and floors. Wall sleeves shall be standard weight steel pipe with ends finished flush with wall surfaces. Floor sleeves shall be one size larger than pipe, unless larger is required to accommodate insulation.

.2 Extend sleeves through potentially wet floors 50 mm above finished floor level. Pack sleeves full depth and provide floor plate. Potentially wet floors are all mechanical rooms, washrooms, kitchen areas, janitor closets, etc.

.3 Where piping or ductwork passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Install chrome plated escutcheons where piping passes through finished surfaces. Escutcheons installed away from walls are not permitted.

.5 Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Consultant before work is done. Furnish and install all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

.6 Pipe sleeves which penetrate perimeter walls shall be of the waterproof type consisting of the following:

.1 12 mm thick circular steel plate escutcheon welded to the sleeve and protruding 150 mm beyond the sleeve diameter. Steel plate escutcheon shall be embedded into the centre of the concrete wall.

.2 Seal the sleeve opening with PC4. Seal the exterior part of the sleeve with the concrete wall waterproofing material and expandable OAKUM.

.7 All openings in walls and floors through which pipes pass shall be caulked with non-combustible asbestos fibre free insulation as protection against both fire, smoke and sound transmission. See Section 07270 for further firestopping requirements.

.8 End portions of the packing shall be impregnated with a fire retardant, lagging adhesive to prevent it from loosening and falling out.

.9 Submit drawings showing sleeving, recesses and formed openings required in the concrete work to the concrete reinforcing steel detailer at the correct time. Completely dimension all openings, recesses and sleeves, and relate these to suitable grid lines and elevation datum.

END OF SECTION

1. GENERAL

1.1 Related Work in Other Section

.1	Metal flashing for built-up roofing	Section 07640
.2	Sealants Section	Section 07910

1.2 Qualifications

.1 Installation work by competent qualified tradesmen only.

2. PRODUCTS

2.1 Materials

.1 Counterflashings - galvanized sheet steel of 0.8 mm minimum thickness.

3. EXECUTION

3.1 Installation

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

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

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

END OF SECTION

1. GENERAL

1.1 Scope

.1 Gate valve.

.2 Globe and angle valves.

.3 Check valves.

.4 Plug cocks.

.5 Butterfly valves.

.6 Radiator valves.

.7 Drain valves.

.8 Hose bibbs.

.9 Balancing valves.

.10 Ball valves.

.11 Circuit balancing valves.

1.2 Manufacturer

.1 Provide valves of same manufacturer throughout where possible.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body. All valves must be suitable in all respects for service used.

1.3 Shop Drawings

.1 Submit detailed shop drawings. Shop drawings shall clearly indicate make, model, location, type, size and pressure rating.

2. PRODUCTS

2.1 Pressure Ratings

.1 Unless otherwise indicated, use valves suitable for minimum 860 kPa WSP at 232°C and 1380 kPa WOG at 121°C.

.2 Use valves for fire protection suitable for 1210 kPa WOG.

.3 Use valves for high pressure fire standpipe systems suitable size 2070 kPa.

2.2 Valve Operators

.1 Provide suitable handwheels for gate, globe or angle, radiation and drain valves, and inside hose bibbs.

.2 Provide one plug cock wrench for every ten plug cocks sized 50 mm and smaller, minimum of one. Provide each plug cock sized 65 mm and larger with a wrench, with set screw.

.3 For butterfly valves provide gear operators for sizes 150 mm and larger. For smaller sizes lever lock handle with toothed plate for shut off service and infinitely adjustable handle with locknut and memory stop for throttling service.

.4 Provide valves located more than 2.1 m from floor in equipment room areas with chain operated sheaves. Extend chains to 1.5 m above floor and hook to clips arranged to clear walking aisles.

2.3 Valve Connections

.1 Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.

.2 Thread pipe sizes 50 mm and smaller.

.3 Flange pipe sizes 65 mm and larger.

.4 Solder or screw to solder adapters for copper tubing.

.5 Use grooved body valves with mechanical grooved jointed piping.

.6 Provide butterfly valves with tapped lug body when used for isolating service.

2.4 Gate Valves

.1 Hot and Cold Domestic Water Service:
- .1 Up to 50 mm:
  - .1 Solder joint bronze body, solid wedge disc, bronze trim, non-rising stem.
  - .2 860 kPa rating - Red and White Fig. 281A.
- .2 50 mm:
  - .1 Screwed bronze body, solid wedge disc, bronze trim, non-rising stem.
  - .2 860 kPa rating - Red and White Fig. 280A.
- .3 65 mm and Larger:
  - .1 Flanged cast iron body, solid wedge disc, bronze trim outside screw and yoke.
  - .2 860 kPa rating - Red & White Fig. 421A.
  - .3 If there is insufficient clearance for a rising stem, use a non-rising stem valve - Red and White Fig. 415A.
  - .4 Where valves are installed high out of operator range, provide chain operator.

.2 Heating/Chilled Water Systems
.1 Up to 50 mm:
.1 Screwed bronze body, solid wedge disc, bronze trim, rising stem, union bonnet.
.2 860 kPa rating - Red and White Fig. 293.
.3 If there is insufficient clearance for a rising stem use a non-rising stem valve - Red and White Fig. 280A.
.2 65 mm and Larger:
.1 Flanged cast iron body, solid wedge disc, bronze trim, outside screw and yoke.
.2 860 kPa rating - Red and White Fig. 421A.
.3 If there is insufficient clearance for a rising stem use a non-rising stem valve, Red and White Fig. 415A.

2.5 Globe Valves

.1 Hot and Cold Domestic Water Service:
.1 Up to 50 mm:
.1 Solder joint bronze body, bronze bevel disc.
.2 860 kPa rating - Red and White Fig. 212.
.2 50 mm:
.1 Screwed bronze body, composition type disk.
.2 860 kPa rating - Red and White Fig. 220.
.3 65 mm and Larger:
.1 Flanged cast iron body, bronze or cast iron bevel type disc, bronze trim, outside screw and yoke.
.2 860 kPa rating - Red and White Fig. 400A.

.2 Heating/Chilled Water Service:
.1 Up to 50 mm - Throttling Service:
.1 Screwed bronze body, stainless steel disc and seat ring, union bonnet.
.2 1380 kPa rating - Red and White Fig. 214.
.2 65 mm and Larger - Isolating Service:
.1 Flanged cast iron body, bronze or cast iron bevel disc, bronze trim, outside screw and yoke.
.2 860 kPa rating - Red and White Fig. 400A.

2.6 Ball Valves

.1 Hot and Cold Domestic Water Service:
.1 Up to 50 mm:
.1 Solder joint brass 2-piece body, blow-out proof stem, PTFE seats, brass chrome plated ball, lever handle operator, full bore.
.2 1034 kPa rating - Red and White Fig. 5049A.
.2 50 mm:
.1 Screwed brass 2-piece body, blow-out proof stem, pipe seats, brass chrome plated lever handle operator, full bore.
.2 1034 kPa rating - Red and White Fig. 5044A.

.2 Heating/Chilled Water Systems:
.1 Up to 50 mm:
.1 Solder joint brass 2-piece body, blow-out proof stem, PTFE seats, brass chrome plated ball, lever handle operator, full bore.
.2 1034 kPa rating - Red and White Fig. 5049A.

.2 50 mm:
.1 Screwed brass 2-piece body, blow-out proof stem, pipe seats, brass chrome plated lever handle operator, full bore.
.2 1034 kPa rating - Red and White Fig. 5044A.

2.7 Butterfly Valves

.1 Hot and Cold Domestic Water System:
.1 65 mm and Larger:
.1 Threaded lug style cast iron body EPDM seat liner, bronze disc 304 stainless steel stem.
.2 10 position lever-lock handle operator up to 150 mm, handwheel worm gear operator 150 mm and larger.
.3 For installation between 860/1030 kPa flanges.
.4 1030 kPa rating - Keystone F1020-CBJ2 trim. Centre line L200L-E.
.5 Suitable for operation at 95°C

.2 Heating/Chilled/Condenser Water System:
.1 65 mm and larger
.1 Threaded lug style cast iron body.
.2 EPDM seat liner (heating), bronze disc.
.3 304 stainless steel stem
.4 10 position lever-lock handle operator up to 100 mm dia.
.5 Handwheel worm gear operator 150 mm and larger.
.6 For installation between 860/1030 kPa flanges.
.7 1030 kPa rating - Keystone F1020 with CBJ2 trim. Centre line L2006-E.
.8 Suitable for operation at 95°C.

.3 Control Valves
.1 Where called for, provide actuator for butterfly valves. Provide weatherproof housing and heater for exterior installation.
.2 For electric control, provide electric modulating actuator with manual handwheel override. Keystone F77 or equal. 120/1/60 motor with 0-10 V control signal.
.3 For pneumatic control, provide pneumatic modulating actuator with position indicator. Keystone F790 or equal. Co-ordinate air pressure with Controls Contractor.

2.8 Balance Valves

.1 Hot and Cold Domestic Water Service:
.1 Up to 50 mm:
.1 Solder joint brass 2 piece body, blowout proof stem, brass chrome plated ball, and balancing plate memory stop with wing handle.
.2 4130 kPa rating - Red & White Fig. 5049-W.
.2 50 mm:
.1 Screwed joint brass 2 piece body, blowout roof stem, brass chrome plated ball, and balancing plate memory stop with wing handle.
.2 4130 kPa rating - Red & White Rig. 5044-W.
.3 65 mm and Larger:
.1 Threaded lug style cast iron body.
.2 EPDM liner, bronze disc.

.3 403 stainless steel stem.
.4 10 position lever - lock handle operator.
.5 For installation between 860/1030 kPa flanges.
.6 1030 kPa rating - Red & White/Toyo Fig. 918-B-E-S-L.

.2 Heating/Chilled Water System:
.1 Up to 50 mm:
.1 Cast iron body eccentric valve, bronze plug nickel plated, screwed ends, adjustable memory stop and lock, Isobutene - Isoprene seals.
.2 Water temperature to 460°C.
.3 1200 kPa rating - Dezurik Fig. 487-S.
.2 65 mm to 100 mm:
.1 Cast iron body eccentric valve, bronze plug nickel plated, flanged ends, adjustable memory stop and lock, lever handle, Isobutene-Isoprene.
.2 Water temperature to 460°C seals.
.3 1200 kPa rating - Dezurik Fig. 487-F.
.3 125 mm and Larger:
.1 Cast iron body eccentric valve, flanged ends, Nitrile-Butadiene packing, Isobutene-Isoprene resilient plug facing, plug operator with adjustable memory stop and lever handle.
.2 Water temperature to 460°C (240°F).
.3 1200 kPa rating - Dezurik Series 100, Fig. 118-F-6-RS55-ANG - Fig. 344.

2.9 Plug Cocks

.1 Iron body, brass plugs and washers, air tested solder or screwed ends.

.2 Iron body and plug, pressure lubricated flanged ends.

2.10 Combination Check and Shut-off Valve

.1 Provide angle or straight type with screwed or flanged cast iron body, and bronze disc and seat.

2.11 Combination Pump Inlet and Strainer Fitting

.1 Provide angle type suction guide fitting with flanged cast iron body, steel or cast iron guide vanes and removable stainless steel strainer.

2.12 Check Valves - Horizontal

.1 Hot and Cold Domestic Water Service:
.1 Up to 50 mm:
.1 Solder joint bronze body, bronze swing disc, and bronze trim.
.2 860 kPa rating - Red and White Fig. 237.
.2 50 mm:
.1 Screwed bronze body, bronze swing disc, and bronze trim.
.2 860kPa rating - Red and White Fig. 236.
.3 65 mm and Larger:
.1 Flanged cast iron body, bronze or cast iron swing disc, bronze trim.
.2 860 kPa rating - Red and White Fig. 435A.

.2 Heating/Chilled Water System:
.1 Up to 50 mm:
.1 Screwed bronze body, bronze swing disc.
.2 860kPa rating - Red and White Fig. 236.
.2 65 mm and Larger:
.1 Flanged cast iron body, bronze or cast iron swing disc, bronze trim.
.2 860kPa rating - Red and White Fig. 435A.

2.13 Check Valves - Vertical

.1 Hot and Cold Domestic Water Service:
.1 Up to 50 mm:
.1 Screwed bronze body, bronze disc.
.2 860 kPa Rating - Red and White Fig. 231.
.2 65 mm and Larger:
.1 Wafer Style cast iron body, Viton "A" body seat, 316 stainless steel clapper seat, arm and pin, 302SS spring, P.T.F.E. thrust washer.
.2 860 kPa rating - W12A-16V.

.2 Heating/Chilled Water System:
.1 Up to 50 mm:
.1 Screwed bronze body, bronze disc.
.2 860 kPa rating - Red and White Fig. 231.
.2 65 mm and Larger:
.1 Wafer Style cast iron body, Viton "A" body seat, 316 stainless steel clapper seta, arm and pin, 302SS spring, P.T.F.E. thrust washer.
.2 860 kPa rating - Moyes and Groves Fig. W12A-16V.

2.14 Radiation Valves

.1 Up to 30 mm:
.1 Union bronze body globe type, rising stem, female by male, teflon disc, bakelite handle, lockshield.
.2 860 kPa rating - Red and White Fig. 252 or 253.

2.15 Drain Valves

.1 Up to 50 mm:
.1 Screwed brass 2 piece body ball valve, blowout proof stem, PTFE seats, brass chrome plated ball, hose end connection with cap and chain.
.2 1034 kPa rating - Red & White/Toyo Fig. 5046 or approved equal.

2.16 Hose Bibbs

.1 Bronze or red brass, replaceable hexagonal disc, hose thread spout, vacuum breaker chrome plated where exposed.
.1 Provide 18 mm drain valves as shown on the drawings and at all low points of piping systems. Provide 40 mm valves for pipe cleaning. Provide hose end adapters on all drain valves. Dahl piggy-back stops of Fig. 21.616 hose bibbs may be used on water systems operating at less than 93°C. Chained caps are required on all drain valves.

.2 Non freeze type with polished bronze recessed box hoses thread, spout, vacuum breaker removable key.

2.17 Strainers

.1 Up to 50 mm
- .1 Screwed bronze "Y" pattern body, 304 SS screen.
- .2 860 kPa rating - Red & White/Toyo Fig. 381A or approved equal.

.2 65 mm & Larger
- .1 Flanged cast iron "Y" pattern body, 304 SS screen.
- .2 860 kPa rating - Red & White/Toyo Fig. 381A or approved equal.

2.18 Circuit Balancing Valves

.1 Up to 50 mm
- .1 Return side of heating/cooling elements TA STA-D.
- .2 Read out ports, drain valve and cap.
- .3 Position readout and memory.
- .4 Poly urethane packaging (R4-5) to be used as removable insulation.

.2 65 mm to 300 mm
- .1 Return side of heating/cooling elements and distribution branches. TA STA-F.
- .2 Read out ports.
- .3 Position readout and memory.

.3 Provide flow meters with appropriate ranges to provide flow readout.
- .1 For installations up to 20 valves, provide standard gauge meter.
- .2 For larger installations, provide TA CBI computerized balancing meter.

2.19 Flanged Connections

.1 Gaskets - 1.5 mm compressed asbestos - JM 60

.2 Bolts & Nuts - stud bolts, carbon steel nuts - A193-Gr87,A194-Gr2H.

2.20 Automatic Air Vents

.1 Armstrong Auto-vent series.

3. EXECUTION

3.1 Installation and Application

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

.2 Install gate or ball valves for shut off and isolating service, to isolate equipment, part of system, and vertical risers. Ball valves shall be used up to and including 50 mm.

.3 Install globe or angle valves for throttling service and control device or meter bypass.

.4 Provide spring loaded check valves on discharge of condensate pumps, condenser water and water booster pumps

.5 Use plug cocks for gas service.

.6 Use plug cocks in water system for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

.7 Use butterfly valves in heating, chilled and condenser water systems interchangeably in place of gate valves on all piping 65 mm and larger.

.8 Use butterfly valves in fire protection systems where approved. Use OS&Y gate valves on inlet side of fire and jockey pumps and for window deluge systems.

.9 Provide drain valves at main shut-off valves, low points of piping, apparatus and strainers. Provide fill/drain valves for all closed piping systems.

.10 Provide gate or ball valve in hot and cold water lines serving a male or female washroom group of fixtures at each hose bibb and at all equipment requiring isolation.

.11 Use bronze body ball valves for domestic water service.

.12 Provide valves upstream of all meters, gauges, automatic air vents, etc. for isolation purposes.

.13 Run line size pipe to floor drains from all drain cocks, drain valves, etc.

.14 Provide main piping system drain valves as a low point and pipe to drain. Drain valves shall be 2 pipe sizes smaller than largest mains and minimum 25 mm.

.15 Provide isolation valves in all systems such that floor by floor for horizontal systems, all risers in a vertical system and zone areas on a large horizontal system can be isolated.

.16 Use lug type valves as required to permit equipment maintenance.

.17 Spring loaded water check valves shall be located 8 pipe diameters downstream of pumps or elbows.

3.2 Combination Check and Shut-Off Valve

.1 Provide on discharge side of mounted centrifugal pumps where indicated.

3.3 Combination Pump Inlet and StrainerFittings

.1 Provide on suction side of base mounted centrifugal pumps where indicated.

.2 Support fitting with floor mounted pipe and flange support to eliminate undue stress on pump suction connection.

END OF SECTION

1. GENERAL

1.1 Scope

.1 All pumps except where integral with a manufactured piece of equipment.

.2 Pumps controls where self contained.

1.2 Submittals

.1 Submit with shop drawings certified curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

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 binding and cavitation, are non overloading in parallel or individual operation; operate within 25% of midpoint of published maximum efficiency curve.

.3 Where pumps are operated in conjunction with others such as parallel pumps, show all operating points on the pump curve.

.4 Ensure installation complies with Workers' Compensation Board requirements.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

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

.3 Pumps shall operate at 1750 r/min. unless specified otherwise.

.4 Pump connections shall be flanged.

.5 Heating pumps shall be suitable for handling water at 110°C.

.6 Domestic water pumps shall be all bronze construction.

2.2 Base Mounted Pumps

.1 Type: Centrifugal, single stage, end suction or double suction as specified.

.2 Casing: radially split end suction horizontally split double suction, cast iron volute rated for 1225 kPa or ductile iron rated for greater than 1225 kPa working pressure, seal flushing connections, air vent, drain plug, suction and discharge gauge ports.

.3 Impeller: Bronze or cast iron, fully enclosed, statically and dynamically balanced, keyed to shaft, held in place by self-locking bronze capscrew and nut. Pumps on brine service shall have iron impellers and stainless steel shafts.

.4 Shaft: carbon steel with stainless steel shaft sleeve.

.5 Bearing: Heavy duty ball bearings sealed for life.

.6 Drive: connected flexible coupling with coupling guard.

.7 Seals: stainless steel spring loaded carbon rotating against a ni-resist seat with EPDM bellow and O-ring.

2.3 Vertical In-Line Pump - 3.73 kW and Under

.1 Type: Centrifugal, single stage, closed coupled in-line, radially split, designed for vertical operation.

.2 Casing: Cast iron, rated for 1225 kPa, or ductile iron for greater than 1225 kPa working pressure, suction and discharge gauge prots, air vent, seal flushing connections, and drain plug.

.3 Impeller: Bronze or cast iron, fully enclosed, keyed to shaft with self-locking bronze capscrew and nut.

.4 Shaft: carbon steel with bronze or S.S. shaft sleeve.

.5 Seals: spring loaded carbon rotating face, ni-resist stationary seat and EPDM secondary seal, fitted with factory installed flush line.

.6 Pump Suction Diffuser: Provide on all vertical in-line pumps c/w 12 mm drain valve.

.7 Vertical inline pumps to be pipe supported only. Do not support off of pump casing.

2.4 Vertical In-Line Pumps - 5.6 kW and Over

.1 Type: Centrifugal, single stage, radially split, split-spacer coupling, designed for vertical installation.

.2 Casing: Cast iron, rated for 1225 kPa, or ductile iron for greater than 1225 kPa working pressure, suction and discharge gauge tappins, air vent, drain plug, flanged suction and discharge connections.

.3 Impeller: Bronze, fully enclosed, keyed to shaft with self-locking bronze capscrew and nut.

.4 Coupling: high tensile aluminium, split type to permit servicing of pump without disturbing pump or motor and shall be protected by coupling guard.

.5 Seals: outside balanced mechanical seal with carbon rotating against a ceramic stationary set and fitted with factory installed flush line. Inside unbalanced seals will be reviewed as an alternate only.

2.5 In-Line Circulators

.1 In-line circulator pumps shall be of type, size and capacity as specified on the drawings.

.2 Pump shall be standard iron body for all applications except domestic water and indirect hot water heating where all bronze construction is required.

.3 Pump shall be equipped with a 1750 r/min. drip proof, resilient mount, sleeve bearing motor.

.4 The pump shaft shall be carbon steel alloy with an integral thrust collar and shall be supported by two oil lubricated bronze sleeve bearings. Pump to be equipped with a water-tight long-life mechanical seal.

.5 Impeller shall be ohenolic, bronze or cadium plated steel.

2.6 Submersible StormWater and Sanitary Pumps

.1 Type: Completely submersible vertical centrifugal.

.2 Casing: Cast iron volute and oil filled motor chamber.

.3 Impeller: Bronze or cast iron, non-clog, on corrosion resistant alloy steel shaft.

.4 Bearing: Ball bearings.

.5 Accessories:
- .1 Oil resistant power cord with 3 prong connection.
- .2 Cema 1 Duplex lockable control panel wall mounted with pump circuit breakers, magnetic contactors, H.O.A. switches, run lights, manual overload reset high level alarm wired to contacts, light, terminal strip and wiring diagram. Vandal proof lockable cover where accessible to public.
- .3 Remote high water and overload alarm.
- .4 Mercury type 2' long level controls.
- .5 Level control bracket.
- .6 Junction box.
- .7 Check valves.
- .8 Discharge adapters.

.6 Cover for each sump and access covers in cover shall be provided by the pump manufacturer c/w curb ring, seals, lifting chains etc. Covers shall be suitable for heavy loading and shall be sized to suit sump size and frame requirements.

.7 All connections such as elect. and piping to, from sumps shall run under the floor slab to walls and run up or down tight to walls.

.8 Provide dry contacts from a high level and overload alarm.

3. EXECUTION

3.1 Installation

.1 Provide drains for bases and stuffing boxes piped to and discharging into floor drains.

.2 Provide air cock and drain connection on horizontal pump casings.

.3 Provide line sized gate valve and strainer on suction and line sized soft seated check valve and memory stop balancing valve on discharge.

.4 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 support under elbows on pump suction and discharge line sizes 100 mm and over.

.5 Check and align base mounted pumps prior to start-up.

.6 Shave or replace pump impellers to meet actual operating conditions.

.7 Where remote control panels are used, this contractor shall allow for wiring from panel to pumps.

.8 Provide spacer at inlet and outlet on vertical in-line pumps complete with screen diffuser.

3.2 Performance

.1 Refer to the pump schedule.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Inertia bases.

.2 Vibration isolators.

1.2 Reference Standard

.1 Provide and install appropriate vibration isolation materials/products on mechanical equipment so that Average Noise Criteria curves, as outlined in ASHRAE Guide, are not exceeded.

1.3 Related Work

.1 Flexible connections Section 15060 (Piping) and Section 15840 (Ductwork).

1.4 Submittals

.1 Provide vibration isolation shop drawings showing isolator locations, load on each isolator, inertia slab dimensions.

.2 Provide details and calculations for attachment of isolator to equipment and structure. Drawings to show calculated tension and shear forces at anchor/structure interface and device/equipment interface. Drawings must confirm that the isolator restraint component or independent restraint device meets or exceeds the project seismic requirements.

1.5 General Requirements

.1 Supply vibration isolation equipment and materials by one supplier. Consider side loading of equipment and inertia bases when calculating maximum loads on isolators.

.2 Equipment supplier to ensure equipment is sufficiently rigid for isolator point loading. Project Mechanical Consultant must be advised of any equipment which requires an additional support base, at least 7 working days prior to tender closing.

.3 All elastomeric components in type 1, type 2 isolation mounts shall be bridge bearing neoprene, meeting CSA Standard CAN3-S6 Section 11.10.

1.6 Description

.1 Provide vibration isolation on all motor driven equipment with motors of 0.37 kW and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 0.37 kW, provide neoprene grommets at the support points.

.2 Co-ordinate with Section 15860 flexible connections for all ductwork connections to fans or plenums.

.3 Electrical cable connected to isolated equipment shall allow for a minimum +-1" of equipment movement in any direction.

.4 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness in selection of elastomers and do not exceed 60 durometer.

.5 Isolators and restraining devices which are factory supplied with equipment shall meet the requirements of this section.

.6 Provide concrete inertia bases where specified or required by equipment manufacturer located between all vibrating equipment and the vibration isolation elements. Provide inertia bases on centrifugal fans with static pressure in excess of 875 Pa and/or motor in excess of 40 HP and on base mounted pumps over 10 HP, except slab on grade installations. Refer to structural specifications for concrete work. Concrete work by General Contractor.

.7 Co-ordinate with Division 3 for the provision of housekeeping pads at least 100 mm high under all isolated equipment. Provide at least 175 mm clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.

.8 Bolt all equipment to the structure. Do not bridge isolation elements.

1.7 Qualifications/Submittals

.1 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements and steel bases for review before materials are ordered. Provide attachment to both the equipment and the structure meeting the specified forces involved.

.2 Submit samples of materials required to complete the work of this section for inspection and review if and when requested.

2. PRODUCTS

2.1 Isolators

.1 Supply all of the vibration isolation equipment by one approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery which must meet the requirements of section 15200 and this section.

.2 All isolators shall be of the following types, supplied by approved manufacturers

.1 Type 1 - Neoprene Pad Isolator
Neoprene isolators to be of bridge bearing quality(see 1.5.3) and not to exceed 60 durometer. Design deflection under load to be a minimum 0.075"(1.9mm) and not to exceed manufacturers maximum loading. Bridge bearing quality neoprene hemi-grommets must be used in conjunction with the neoprene pad to ensure that the isolation is not compromised by the required anchor bolts. Load distribution plates shall be used where required. Acceptable products: Mason Super W and HG hemi-grommets.

.2 Type 2 - Neoprene mounts
Neoprene mounts shall consist of a ductile iron casting containing separate and opposed molded bridge bearing neoprene(see 1.5.3) elements, which shall prevent the central threaded sleeve and equipment attachment bolt from contacting the casting during normal operation. Nominal static deflection under load shall be 0.2"(5mm). No mount shall be loaded to less than 50% of this deflection nor exceed the manufacturer's maximum recommended loading. Acceptable products: Mason BR

.3 Type 3 - Spring Isolators
Spring isolators shall be free standing, laterally stable and supplied complete with a lower molded neoprene acoustical cup. All mountings shall have a leveling bolt that allows for rigid attachment to the equipment. Spring diameters shall be no less than 80% of compressed height at rated load and have an additional travel to solid of 50% of rated load. Nominal static deflection shall be 1"(25mm). No spring shall be loaded to less than 70% of its rated capacity nor exceed manufactures capacity. Potential impact areas to be protected by a minimum of a 1/8" (3.2mm) neoprene bushing. Submittals to include spring diameter, rated deflection, spring constant, and free and operating height. Acceptable products: Mason SLF(must be used with type 5 or 5PD snubber), Mason SSLFH(for non post-disaster applications)

.4 Type 3A - Spring Isolators for Variable weight Equipment (Chillers, Cooling Towers)
Restrained spring mountings shall incorporate spring(type 3), within a rigid steel housing that includes a minimum of two vertical limit stops to prevent spring extension when weight is removed. the housing shall serve as blocking during installation and steel spacers shall be removed after adjustment such that the installed and operating heights are the same. An air gap of 1/8"(3mm) in all directions, before contact is made between the rigid and resilient surfaces, shall be incorporated into the design. Limit stops shall be out of contact during normal operation. Since housing may be bolted or welded into position, there must be an internal isolation pad under the springs. Acceptable produce: Mason SLR, SSLR, SLREBP, HSLR

.5 Type 4 - Air Spring Isolator
Air springs shall be manufactured with upper and lower steel sections. The upper section shall be integral with a rolling lobe reinforced elastomeric air reservoir which will be molded to sit into the lower steel section of the mount. Air inlet to the air spring assembly shall be from the side. Natural frequency at 100psi shall be 1.5Hz. All air spring systems shall be interconnected and supplied by either building control air or a supplementary air supply(by others). The air spring system shall be supplied complete with three leveling valves to maintain the level of the isolated equipment, in both horizontal planes to within +- 1/8"(3mm). Air springs shall be fitted within an OSHPD approved integral housing(see type 3A). Acceptable products; Mason MAS Air Springs (with type 5 or 5PD snubbers), Mason SLR-MAS, Mason DS-206 leveling valves.

.6 Type 6N - Neoprene Isolation: Curb Mounted Rooftop Equipment
Internally isolated curb mounted equipment shall be externally isolated on 1/2"(12mm) thick perimeter strips of closed cell neoprene sponge of appropriate density and width to ensure that deflection under load does not exceed 1/8"(3mm). Bridge bearing quality neoprene hemi-grommets or washers and cylinders must be used in conjunction with the neoprene sponge to ensure that the isolation is not compromised by the required anchor bolts. Acceptable products: Mason type HG

.7 Type 6S - Spring Isolation Curbs: Rooftop Packaged Air Handling Equipment
Curb mounted equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable springs(see type 3) that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4"(6mm) thick. Steel springs shall be laterally stable and rest on a 1/4" (6mm) thick neoprene acoustical pads. Hardware must be plated and springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall

have provision for 2" (50mm) thick insulation. The equipment must be solidly fastened to the top floating rail, and the lower Z section anchored to the roof structure. Acceptable products: Mason RSC

.8 Type 7N - Neoprene Hangers

Double deflection neoprene hangers shall consist of a rigid steel frame containing a neoprene element with an upper embedded steel washer and an integral bottom flange which will protrude and friction fit into the lower circular opening of the hanger frame. The lower hole in the hanger box shall be of a large enough diameter to permit the threaded hanger rod to swing through a minimum 15º arc from side to side before contacting the neoprene flange. Nominal static deflection under load shall be 0.2"(5m). No hanger shall be loaded to less than 50% of this deflection nor exceed the manufacturers maximum recommended loading.

.9 Type 7S - Spring Isolation Hangers

Spring isolation hangers shall consist of a rigid steel frame containing a steel spring(see Type 3) and shall be seated in a steel washer reinforced neoprene cup. This cup shall have a neoprene bushing projecting through the steel box. Spring diameters and hanger box lower hole diameters shall be large enough to permit the hanger rod to swing through a 15º arc from side to side before contacting the protruding neoprene bushing. Spring selection and submittal data similar to that for Type 3. Acceptable products: Mason HS

.10 Type 7SN - Spring Hangers with Neoprene Elements

Spring hanger assemblies similar to type 7S but with the inclusion of an upper 1-1/4" (32mm) thick neoprene element situated at the top of the hanger. Spring diameters and hanger box lower hole diameters shall be large enough to permit the hanger rod to swing through a 30º arc from side to side before contacting the protruding neoprene bushing. Acceptable products: Mason 30N

.11 Type 8 - Isolation Grommets

Low weight equipment having a drive less than 0.5Hp(0.37kW) shall be vibration isolated using a two piece grommet assembly specifically designed for that purpose(electrical grommets are not acceptable). One section of grommet shall consist of an integral washer and cylinder, the other section shall be an isolation washer having and ID equal to OD of the cylinder component of the other section. Acceptable products: Mason HG/HGW assemblies, E.A.R. grommets

.12 Type 9 - Horizontal Thrust Restraints

Spring isolated air handling equipment shall be fitted with horizontal thrust restraints design to keep movement due to thrust to +-1/4" (6mm) at equipment start and stop. Restraints shall consist of a pair of type 3 springs, complete with neoprene molded cups having the same deflection as those specified for the equipment. The restraints shall be attached at the centreline of the thrust and symmetrical on each side of the unit. Acceptable products: mason WBI/WBD

.13 Type 10 - Acoustical Split Wall Seals

Split wall seals shall consist of two bolted pipe halves with a minimum 3/4"(19mm) thick neoprene sponge bonded to the liner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall, or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum 1" (25mm) past both sides of the wall. Where temperatures exceed 240ºF(113ºC) 10# density fiberglass may be used in lieu of the sponge. Acceptable products: Mason SWS

.14 Type 11 - Pipe Riser Anchors

All directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed

500psi and be designed to balance for equal resistance in any direction. acceptable products: Mason ADA

.15 Type 12 - Pipe Riser Guides
Guides are to be used in conjunction with type 3 spring isolators and shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow for vertical motion due to pipe expansion or contraction. Guides shall be capable of +-1-5/8" (40m) motion or to meet project requirements. Acceptable products: Mason VSG

.3 Select isolators at the supplier's optimum recommended loading, and do not load beyond the limit specified in the manufacturer's literature.

.4 Design springs in accordance with the Society of Automotive Engineers' Handbook Supplement 9 entitled "Manual on Design and Application of Helical and Spiral Springs - SAE - 1975".

.5 Design springs "iso-stiff" (kx/ky = 0.8 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.

.6 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for all isolation equipment located out of doors or in areas where moisture may cause corrosion.

2.2 Bases

.1 Type B1 - Concrete Inertia Bases
Provide concrete inertia bases a minimum of 1.5 times the weight of the isolated equipment. Generally base thickness shall be 1/12 of the longest dimension of the base, but not less than 150 mm (6"). Include with base a steel channel concrete form with required steel reinforcement (as determined necessary by suppliers' registered professional engineer). Provide additional steel as required by sleeves or inserts to receive equipment anchor bolts. Use height saving brackets in all mounting locations to maintain a 50 mm (2") clearance below the base. Bases to be furnished with built-in motor slide rails. Motor location as specified/scheduled. Acceptable products: Mason type K

.2 Type B2 -Structural Steel Bases
Construct structural steel bases sufficiently rigid to keep deflection and misalignment within acceptable limits as determined by the equipment manufacturer. Use height saving brackets in all mounting locations to provide a base clearance of 50 mm (2"). Bases to be furnished with built-in motor slide rails. Motor location as specified/scheduled. Acceptable products: Mason type WF

.3 Bases to be provided by vibration isolation supplier or manufactured by the Contractor in strict accordance to vibration isolator supplier's drawings.

.4 Cooling tower bases shall be type B2. Bases to be provided by vibration isolation supplier or manufactured by the Contractor in strict accordance to vibration isolator supplier's drawings.

2.3 Flexible Duct Connectors

.1 Provide flexible duct connectors of Durodyne with Durolon fabric or approved equal.

2.4 Flexible Pipe Connectors

.1 At the last elbow before piping leaves the mechanical room, and the first elbow entering, provide a bolted flanged 2000mm long spool piece to facilitate the future installation of. vibration reducing flexible connector, as described in 2.5 below. Provide a shut off valve on either side of the spool piece.

2.5 Flexible Pump and Chiller Connections

.1 Install flexible connections for all centrifugal floor mounted pumps, in line pumps, chillers and cooling towers in such a manner that vibrations and transmission thereof are eliminated. Flexible connectors shall be twin sphere, peroxide cured EPDM, Kevlar reinforced, solid steel rings with raised face rubber flanged ends, ductile iron external ring between spheres, Mason SafeFlex SFDEJ, or equal, and shall be installed as per manufacturer's recommendations.

3. APPLICATION AND EXECUTION

.1 Vibration isolation products as outlined in section 2 above are to be applied based on 4 basic project specific situations. The requirements for each of these is outlined below:

.1 Acoustical classification AAA - Hospitals, Recording Studios, Theatres, High end Hotels

.2 **Acoustical classification AA - Office Towers, Multi Storey Condominiums**

.3 Acoustical classification A - Commercial

.4 Acoustical classification W - Warehouse, Industrial

.2 This project has an acoustical classification of AA. See table 3.0T1 for vibration isolation application requirements.

.3 Pre-approved manufacturers and products are as indicated in Section 15010.

.4 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.5 For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm to other structures, piping, equipment, etc.

.6 Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.

.7 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing anchors.

.8 Where hold down bolts for isolators penetrate roofing membranes, provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene.

.9 Connect emergency generator mufflers directly to structure. (Flex connection between generator and exhaust piping provided by Div 16)

.10 Isolation hangers, as outlined in table 3.0T1, shall be provided on all piping in mechanical and boiler rooms for a minimum of the first three support points for piping up to 4"(100mm) diameter, first four support points for piping 5"(125mm) to 8"(200mm) diameter and for the first six points on piping 10"(250mm) diameter and above.

.11 Flexible pipe connectors per 2.5.1 shall be provided and installed per Table 3.0T1. Where not required, Contractor shall make provision for possible future installation by installing appropriate spool pieces.

.12 Where piping connected to noise generating equipment is routed from the mechanical room through plumbing chases, position piping to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Submit proposed details to meet this requirement. On all AAA and AA projects, type 10 acoustical seals shall be provided on piping entering or leaving mechanical rooms.

.13 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal.

3.2 Duct Connections to Isolated Equipment

.1 Provide 75 mm flexible duct connectors and a 40 mm metal to metal gap.

.2 Flexible duct connections shall be installed so that duct size is not reduced by the deflection of the flexible connector.

3.3 Inspections

.1 The supplier shall provide assistance to the contractor as necessary during the course of installation of isolation equipment. Prior to substantial completion, supplier shall provide a written report, listing any deficiencies, directly to the Project Mechanical Consultant.

TABLE 3.0TI

EQUIPMENT	AAA	AA	A	W
Cooling Towers	4, B2 & 2.5.1	4, B2 & 2.5.1	3A, B2 & 2.5.1	1, B2 & 2.5.1
Multi-Stage Centrifugal Chillers (upper storey) (on grade)	4, B2 & 2.5.1 3A, B2 & 2.5.1	4, B2 & 2.5.1 3A, 2.5.1	3A, B2 & 2.5.1 2 & 2.5.1	1 -
Chillers - Other (upper store) (on grade)	3A, B2 & 2.5.1 2 & 2.5.1	3A, B2 & 2.5.1 2 & 2.5.1	2 1	1 -
Pumps>10 hp floor mounted (upper floor) (on grade)	3, B1 & 2.5.1 3, B1 & 2.5.1	3, B1 & 2.5.1 2, B1 & 2.5.1	2, B1 & 2.5.1 2 & 2.5.1	2 1
>1/2hp< 10hp floor mounted (upper floor) (on grade)	3, B2 & 2.5.1 2, stanchions or B2 & 2.5.1	2, stanchions or B2 & 2.5.1 2, stanchions or B2 & 2.5.1	1, stanchions or B2 & 2.5.1 1	1 -
<<1.2hp floor mounted	8	8	-	-

Heat Pumps & Hung Pumps	7SN & 2.5.1	7S & 2.5.1	7N	-
>>1/2hp	7S & 2.5.1	7N	8	-
<<1/2hp				
Piping - attached to isolated equipment	7SN - See 3.1.8	7SN - See 3.1.8	7SN - See 3.1.8	See 3.1.8
- through Mechanical Room Walls..1½"	10	10	-	-
- hot water risers...no expansion loops	11,12,13	11,12,13	-	-
Compressors				
>>10hp recip. (remote tank)	3, B1 & 2.5.2	3, B1 & 2.5.2	2 & 2.5.2	2
>>10hp centrif. (remote tank)	2 & 2.5.2	2 & 2.5.2	1	-
>>5hp - tank mounted	3, B1 & 2.5.2	3, B1 & 2.5.2	2 & 2.5.2	1
>>5hp - tank mounted	2 & 2.5.2	2 & 2.5.2	1	-
Roof Mounted Packaged Air Handling Equipment				
- internally isolated	6S & 2.3.1	6S & 2.3.1	-	-
- not internally isolated	6S & 2.3.1	6S & 2.3.1	6N & 2.3.1	6N & 2.3.1
Fans				
- floor mounted>>40hp	4, B1, 9(if req'd) & 2.3.1	3, B1, 9(if req'd) & 2.3.1	3, B1, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1
- above grade				
- on grade	3, B1, 9(if req'd) & 2.3.1	3, B1, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1
>>5hp<<40hp<<1200rpm	4, B1, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1
- above grade				
- on grade	3, B1, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	-
>>5hp<<40hp<<1200rpm	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1
- above grade				
- on grade	3, B2, 9(if req'd) & 2.3.1	3, B2, 9(if req'd) & 2.3.1	2, B2, 9(if req'd) & 2.3.1	1,9 (if req'd) & 2.3.1
>>1/2hp<<5hp				
- above grade	3 & 2.3.1	2 & 2.3.1	2 & 2.3.1	1 & 2.3.1
- on grade	2 & 2.3.1	1 & 2.3.1	1 & 2.3.1	-
Hung				
>>5hp<<1200 rpm	7SN & 2.3.1	7S & 2.3.1	7S & 2.3.1	7S & 2.3.1
>>5hp>> 1200 rpm	7SN & 2.3.1	7S & 2.3.1	7N & 2.3.1	8 & 2.3.1
>>1/2hp>>1200 rpm	7S & 2.3.1	7N & 2.3.1	8 & 2.3.1	8 & 2.3.1
Fractional	8 & 2.3.1	8 & 2.3.1	-	-

Note:
Table indicates type of isolation required, base type (B) if required and any other sections of note.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Flexible pipe connections.

.2 Expansion joints and compensators.

.3 Pipe loops, offset and swing joints.

1.2 Reference Standards

.1 Conform to Standard of "Expansion Joint Manufacturers Association" and manufacturer's recommendations.

1.3 Shop Drawings

.1 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.

.2 Expansion joint shop drawings shall include maximum allowance temperature and pressure rating, and maximum expansion compensation.

1.4 General Requirements

.1 Examine piping layout and notify the Consultant of additional anchors or expansion joints required to adequately protect system.

.2 Base expansion calculation on 10°C installation temperature to 100°C for hot water heating and 60°C for domestic hot water plus 30% safety factor.

.3 Make provision for expansion and contraction of all pipe work. All piping shall be anchored and supported in such a manner that strain and/or weight does not come upon any apparatus and pipe branch connections. Expansion joints and compensators shall be installed and guided as per manufacturer's recommendations. All equipment shall be connected with unions or flanges to provide for easy removal. Where piping passes through walls or floor slabs, the sleeves shall be of sufficient size to accommodate the expansion and the pipe insulation without binding or crushing the insulation, or preventing the expansion of the piping.

1.5 Inspection

.1 Provide inspection by flexible pipe manufacturer's representative for final installing and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

2. PRODUCTS

2.1 Flexible Pipe Connections

.1 For steel piping construct with neoprene twin sphere type with control rods.

.2 For copper piping construct with bronze inner hose and braided exterior sleeve.

.3 Use connectors suitable for minimum 860 kPa WSP and 230°C and 1380 kPa WOG and 120°C.

.4 Mason MFTNC.

2.2 Expansion Joints

.1 Steel piping 75 mm and under: stainless steel bellows type with anti-torque device, limit stops and internal guide.

.2 Steel piping over 75 mm: external pressurized guided expansion joint with multiply bellow and limit stops. 1034 kPa rated. Hyspan Series 3500.

.3 Copper piping: all bronze type with two-ply bronze bellows, anti-torque device limit stops, internal guides and solder joint end. Hyspan Type 8510 or equal.

.4 Use joints suitable for minimum 860 kPa WSP and 200°C and 1380 kPa WOG and 120°C.

2.3 Connections

.1 Provide flexible pipe connectors and expansion joints suitable to connect to adjoining piping as specified for pipe joints. Use pipe sized units.

2.4 Guides

.1 Pipe alignment guides shall be Hyspan Series 9500 or equal. Size to accommodate pipe insulation.

2.5 Anchors

.1 Anchors shall securely attach piping to structural members. Size the anchors to accommodate the forces due to the pipe expansion and weight.

.2 Construct anchors from steel plate and channel. Where bolts secure anchor to the structure, weld the bolts to the plate.

.3 Arrange anchors so that bolts are in shear not in tension.

.4 Provide anchors on both sides of expansion devices, as indicated on the drawings, and as required to control the flexing of the piping system.

2.6 Expansion Loops

.1 Provide expansion loops as required. The three legs of the expansion loop shall be equal.

.2 Cold springing of the expansion loop up to 50% of the expansion considered is permitted.

3. EXECUTION

3.1 Applications

.1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation.

.2 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide corrugated bellows type expansion joints where indicated or required.

3.2 Installation

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

.2 Rigidly anchor pipe to building structure at points shown, and where necessary provide 2 pipe guides per side of expansion joint or compensator so that movement takes place along axis of pipe only.

.3 Provide two pipe alignment guides in each side of each expansion joint and expansion loop. Install in accordance with manufacturers recommendations to remove any side motion onto expansion joint.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Provide all required meters, gauges, and thermometers.

.2 Provide flow meters.

1.2 Submittals

.1 Submit shop drawings of meters, gauges, and thermometers.

2. PRODUCTS

2.1 Positive Displacement Meters

.1 Suitable for fluid encountered and similar to those used by utility companies.

.2 Provide Pulse style water meters for cooling tower fluid cooler make-up giving 4-20 Ma output for connection to chemical treatment.

2.2 Pressure Gauges

.1 Gauges shall be 110 mm diameter 1% accuracy cast aluminum case, aluminum ring, phosphor bronze bourdon tube, brass movement, front re-calibrator and glass window.

.2 Dials shall read metric units kPa.

.3 For gauges on liquid service provide a bronze pulsation damper and needle valve.

.4 For steam service provide a straight pigtail syphon and needle valve.

2.3 Pressure Gauge Taps

.1 Provide 6 mm NPT needle valve.

2.4 Thermometers – Liquid Systems

.1 Thermometers shall be 225 mm scale adjustable angle, cast aluminum case or ABS plastic case, red reading mercury, glass front and complete with 20 mm NPT brass separable well, Celsius scale.

2.5 Static Pressure Gauges

.1 Magnehelic - 90 mm diameter dial in case, diaphragm actuated, black figures on white background, front recalibration adjustment,(inclined type manometer and tubing, static pressure tips, and mounting assembly). Manufactured by Dwyer.

2.6 Meter and Gauge Ranges

.1 Meter and gauge range shall be selected to read at midscale of normal operating conditions.

3. EXECUTION

3.1 Installations

.1 Install positive displacement meter with isolating valves. Provide valved bypass for liquid service meters.

.2 Install venturi flow fittings meters in uninterrupted straight pipe, minimum 5 pipe diameters downstream and 10 pipe diameters upstream, on supply lines downstream of pumps.

.3 Provide one differential meter for venturi fittings. Provide meter for each range.

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

.5 Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

.6 Enlarge pipes smaller than 65 mm for installation of thermometer wells.

.7 Install gauges in locations and angles that are easily readable from normal sight.

3.2 Meters and Gauges Schedule (Also Refer to Drawings)

Locate meters and gauges in the following locations and as shown on the drawings.

.1 Positive Displacement Meter
- .1 Cooling Tower Make-Up
- .2 Expansion Tank Make-Up

.2 Pressure Gauges
- .1 Pumps – Suction and Discharge
- .2 Expansion Tanks
- .3 Pressure Tanks
- .4 Standpipe, Highest Point
- .5 Sprinkler System

.3 Pressure Gauge Taps
- .1 Chillers - Inlet and Outlets
- .2 Boilers - Inlet and Outlets

.4 Stem Type Thermometers
- .1 Boilers - Inlets and Outlets
- .2 Chillers - Inlets and Outlets

.5 Static Pressure Gauges
- .1 Built-up Filter Banks

END OF SECTION

1. GENERAL

1.1 General Requirements

.1 Access for maintenance or adjustment of all parts of the mechanical system shall be provided. This shall apply but not be limited to valves, volume dampers including splitter dampers, fire dampers, cleanouts and controls.

.2 Where equipment is concealed by a removable tile ceiling, the location of equipment shall be indicated by coloured markings on the T bar system.

.3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.

.4 Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms.

1.2 Schedule

.1 Provide a schedule of access doors showing location, type and size, together with samples, to the consultant for approval before installation. Avoid locating access doors in feature walls or ceilings without prior approval of the consultant.

2. PRODUCTS

2.1 Access Door Types

.1 Drywall Surface*
Hidden flange: Acudor DW-5040 with flange of textured galvanized steel drywall taping bead with prepunched holes. Installed after drywall.

.2 Masonry: Acudor UF-5000 universal flush door.

.3 Tile Surface: Acudor UF-5000 stainless steel universal flush door.

.4 Plaster Walls and Ceiling: Acudor PS-5030 with expansion casing bead and 75 mm wide galvanized lath surround recessed 19 mm to receive plaster.

.5 Acoustic Plaster: Acudor AP-5010 with 15 mm recessed door lined with self-furring lath and 75 mm wide galvanized lath surround recessed 19 mm to receive plaster.

.6 Acoustical Tile Ceilings: Acudor AT-5020 with 15 mm recessed door to receive acoustic tile.

.7 Fire Rated Walls: Acudor FB-5060 uninsulated doors where temperature rise is not a problem and Acudor FW-5050 insulated door for maximum 250° rise after 30 minutes. Door and frame shall be 16 gauge with masonry anchor straps and carry a ULC - 2 hour 'B' label.

.8 Fire Rated Ceilings: Acudor FB-5050, 50 mm thick insulated door with one hour combustible and three hour non-combustible rating.

2.2 Construction

.1 Flush to frame type steel door with rounded safety corners: 16 GA door, 18 GA frame under 16" x 16", and 14 GA door, 16 GA frame over 16" x 16". Concealed bar hinge and one piece trim flange.

.2 For ductwork provide access doors with lever locks, insulated for insulated ductwork.

.3 Cam type, screwdriver operated locking device on the side opposite the hinges.

.4 Prime coat grey baked enamel after 5 stage iron phosphate preparation, or stainless steel #4 satin finish where required.

.5 300 mm x 300 mm minimum for inspection and hand access.

.6 450 mm x 450 mm minimum, larger if indicated on drawings, where entry is required and access is difficult.

.7 Size to suit masonry modules when located in a masonry wall.

.8 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface material and pattern if this is available at the time the units are ordered.

3. EXECUTION

3.1 Installation

.1 Access doors are to be provided by the Mechanical Division. Installation in building construction to be by the general contractor. Access doors in mechanical equipment to be provided and installed by the mechanical division.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Expansion tanks.

.2 Accessories and connection to piping system.

.3 Saddles and structural supports.

1.2 Standards

.1 Construct pressure tanks to ASME Code and Alberta Pressure Vessel Act for unfired pressure vessels.

.2 Comply with provincial government regulations.

1.3 Submittals

.1 Submit as part of shop drawings for domestic hot water storage tanks, specifications and installation instructions for tank lining method.

.2 Submit, as part of shop drawings for underground fuel storage tanks, manufacturer's installation instructions.

1.4 Inspections

.1 Obtain inspection certificates for pressure vessels from Provincial Authorities. All inspection costs to be Contractors responsibility.

2. PRODUCTS

2.1 Expansion Tanks

.1 Tank shall be closed type, welded steel ASME rated and approved for working pressure of 860 kPa cleaned, prime coated and supplied with steel support saddles.

.2 Construct tank with necessary tappings for installation of accessories.

.3 Provide gauge glass set consisting of brass compression stops and floating ball stops and guard. Glass shall be long enough to cover the tank from 50 mm above the bottom to 50 mm below the top. Maximum length of each glass shall be 600 mm.

.4 Provide quick connect air inlet of automotive tire valve type and tank drain.

.5 Provide temperature and pressure relief valve, and automatic cold water fill assembly complete with pressure reducing valve, reduced pressure double check back pressure valve with test cocks, strainer, vacuum breaker and valves by-pass.

.6 Provide inspection manhole and/or inspection openings for tanks as required by code.

.7 Air Chamber: heavy duty butyl diaphragm bonded with poly propylene liner to steel shell, separating air chamber from water. Pre-charge to 80 kPa.

3. EXECUTION

3.1 Installation

.1 Support tanks inside building structure as specified and as indicated on drawings.

.2 Flush and clean fuel tank prior to delivery to site and keep sealed during construction.

.3 Bolt tanks to the structure.

3.2 Performance

.1 Provide tanks of dimensions and capacities indicated in the tank schedule or as noted on the drawings.

.2 Set expansion tank pressure relief valve.

3.3 Tank Schedule

.1 Refer to drawings and mechanical equipment schedule this specification.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Provide piping insulation.

.2 Provide ductwork and plenum insulation.

.3 Provide equipment insulation.

.4 Provide adhesive, tie wires, tapes.

.5 Provide recovering.

1.2 Definitions

.1 "Concealed" piping, ductwork and equipment shall include all piping, ductwork and equipment in ceiling spaces and inaccessible service shafts. All other locations including mechanical rooms shall be considered exposed unless specifically noted otherwise.

1.3 Quality Assurance

.1 Have insulation installed by skilled workmen regularly engaged in this type of work.

1.4 Submittals

.1 Submit shop drawings which indicate complete material data, a list of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit, as requested by the Consultant, samples or proposed insulating materials.

1.5 Job Conditions

.1 Deliver material to job 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 manufacture. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.6 Alternatives

.1 Alternative insulations are subject to approval. Alternatives shall provide the same thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Adhesive Insulation Materials & Recovery Jackets: Composite fire and smoke hazard ratings shall not exceed 25 for Flame Spread and 50 for Smoke Developed. Adhesives shall be waterproof.

2.2 Materials

.1 Cold Piping: Fine fibrous glass insulation, with factory applied vapour barrier jacket, molded to conform to piping "K" value at 24 Cel. maximum 0.033 W/m. Cel.

.2 Hot Piping: Fine fibrous glass insulation with factory applied general purpose jacket, molded to conform to piping "K" value at 24 Cel. maximum 0.033 W/m. Cel.

.3 Refrigerant Piping: Foamed plastic of closed structure "K" value at 24 degrees C. maximum 0.04 W/m. C. maximum water vapour transmission rating of 0.1 perms. Insulation similar to Armstrong "Armaflex" or Fiberglass "Tundra".

.4 Roof Drains and Storm Drains: Flexible fibrous glass insulation, "K" value at 24 Cel. maximum 0.033 W/m. Cel. with factory applied reinforced aluminum foil vapour barrier.

.5 Hot Ducts: Flexable mineral fibre blanket, "K" value at 24 Cel. maximum 0.040 W/m. Cel. Rigid mineral fibreboard, "K" value at 24 Cel. maximum 0.033 W/m. Cel.

.6 Cold Ducts: Flexable mineral fibre blanket with factory applied reinforced aluminum foil vapour barrier, "K" value at 24 Cel. maximum 0.040 W/m. Cel. Rigid mineral fibreboard, blanket with factory applied reinforced aluminum foil vapour barrier, "K" value at 24 Cel. maximum 0.033 W/m. Cel.

.7 Hot Equipment: Rigid fibrous glass insulation with factory applied general jacket, "K" value at 24 Cel. maximum 0.035 W/m.Cel.

.8 Cold Equipment: Rigid fibrous glass insulation with factory applied reinforced aluminum foil vapour barrier, "K" value at 24 Cel. maximum 0.035 W/m.Cel.

.9 Recovery Jacket: ULC labelled thermocanvas 220 g/sq. m flame spread less than 25, smoke developed less than 50. PVC plastic, Z Easton 2000, one piece molded type fitting covers and jacketing materials, gloss white, pressure sensitive, color matching vinyl type.

.10 Emergency Generator Exhaust: Calcium silicate, asbestos free, molded to conform to piping "K" value at 149°C maximum 0.058 w/m cel, 16 gauge stainless steel tie wire.

.11 Exterior Piping: Apply aluminum jacketing 0.045 mm thick, 50 mm laps 1with stainless steel clamps.

.12 Boiler Breeching: Calcium silicate, asbestos free, molded to conform to piping "K" value at 149°C maximum 0.058 w/m cel, 16 gauge stainless steel tie wire.

.13 Acoustic Lining: Flexible duct liner fibreglass insulation, "K" valve at 24 Cel. maximum 0.036 W/m. cel absolute roughness not to exceed 0.58 mm, coated to prevent fibre eroson on exposed surfaces, 0.70 minimum noise reduction coefficient.

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 non fire rated inside walls. Pack around pipes with fire proof self-supporting insulation materials, properly sealed, passing through fire rated walls.

.2 Insulate fittings and valves, strainers, victaulics and air separators. Do not insulate unions, flanges. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Finish insulation neatly at hangers, supports and other protrusions.

.4 Locate insulation or cover seams in least visible locations.

.5 Provide recovering jacket on exposed insulation throughout, including equipment room. Insulation located in crawl spaces, pipe shafts and suspended spaces is not considered exposed. Use presized paper under recovering at uneven insulated surfaces.

.6 Cover insulation exposed to outdoors with 13.6 kg coated glass base sheet with aluminum bands on 200 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.7 On vertical piping with diameters 25 mm and larger, use insulation supports welded or bolted to pipe directly above lowest pipe fittings. Repeat supports on 4.5 m centres and at each valve and flange.

.8 Do not insulate ductwork with external thermal insulation where acoustic lining has been specified.

.9 Cold Piping: Cover fittings and valve bodies and stems, strainers, elbows, flanges and interior storm piping system with equivalent thickness of insulation material. Cover with open mesh glass cloth sealed with vapour barrier sealant and adhesive. Seal butt joints with 100 mm wide strips or vapour barrier sealed with vapour barrier adhesive. For exposed fittings, elbows and valves, apply hydraulic setting cement paste over insulation material before applying recovering.

.10 Hot Piping: Cover fittings and valve bodies and stems, strainers and flanges with equivalent thickness of insulation material. Recover. For exposed fittings and valves apply hydraulic setting cement paste over insulating material before applying recovering.

.11 Refrigerant Piping: Cover fittings and valves with equivalent thickness of insulation material. Apply with edges tightly butted. Seal joints with vapour barrier tape or sealer.

.12 Roof Drains and Vents: Adhere flexible insulation with adhesive applied in 150 mm wide strip on 400 mm centers. Provide 1.6 mm annealed tie wire tied, spiral wound or half hitched at 400 mm centers for securing insulation until adhesive sets. Butt insulation and seal joints and breaks with 50 mm of foil adhered over joint.

.13 Equipment: Apply insulation with edges tightly butted, joints staggered and secured in place by steel bands. Where necessary weld on suitable anchors. Provide sufficient clearance around openings for normal operation of equipment. Finish hot surface insulation with 25 mm galvanized hexagonal mesh and coat with hydraulic setting insulation cement. Finish cold surface insulation joints with 100 mm wide strips of vapour barrier sealed with vapour barrier adhesive finish insulation with heavy coat of vapour barrier adhesive finish over whole body. Finish with a final coat of cement containing 25 % by weight of Portland Cement. Recover and provide and extra coat of lagging adhesive.

.14 Face breeching with 9.5 mm Lath turned put to provide air 12mm space between insulation and hot surface and 12.5 mm mesh together and coat with 12mm thick asbestos cement paste apply to layers with 25% portland cement in second layer. Trowel to a smooth hard finish.

.15 Acoustic lining: Secure to ductwork with adhesive using 100% coverage and impale on anchor tabs on 400 mm centres, secure in place with retaining clips. Remove excess length of pins and cover with brush coat of mastic. Provide vapour barrier on warm side for outside air intakes and exterior ductwork. Bevel corners at joints and butt together. Brush coat all cut edges with lap seal adhesive.

.16 Generator Exhaust: Tightly butt insulation with staggered joints secured with metal bands or wire. Cover fittings with equivalent thickness of hydraulic setting cement applied over wire mesh. (Cover with 0.8 mm aluminum sheet).

.17 Provide finished openings for electrical and lubrication connections. Extend wrapping 150 mm beyond fan. Provide metal bands to secure assembly.

.18 Provide inserts between support shield and piping on piping 40 mm diameter or larger, high density insulating material suitable for temperature. Inserts shall not be less than the followings lengths:

.1	40mm to 65mm	250mm long
.2	75mm to 150mm	300mm long
.3	200mm to 250mm	00mm long
.4	300mm and over	500mm long

3.3 Insulation Thickness Schedule

	PIPE SIZES	INSULATION THICKNESS(mm)
Chilled Water Piping	All Sizes	25
Domestic Cold Water Piping	Up to 25 mm Over 25 mm	12 25
Domestic Hot Water Piping(including recirc Lines).	Up to 25 mm Over 25 mm	12 25
Hot Water Heating Piping (In radiation enclosures only insulate piping mains)	Up to 200 mm 25 to 200 mm 250 mm & over	25 25 50
Refrigerant Suction, Liquid, Piping	All Sizes	25
Roof Drains, vertical connections between roof drains and horizontal piping, and horizontal piping	All sizes	25
Vents (within 3 m of Roof Outlet.)	All sizes Over 50 mm	25 25
Exhaust and relief ducts within 3 m of exterior openings and entire length through cold spaces)	All sizes	25
Combustion Air	All sizes	50
Outside Air	All sizes	50
Supply ducts	All sizes	25
Traps on Handicapped Lavatories		25
Expansion Tanks Chilled and Heating Water		50
Emergency Generator Exhaust Pipe and Muffler (Inside Bldg.)		50
Breaching, Boilers	All Sizes	50

END OF SECTION

1. GENERAL

.1 Refer to architectural and mechanical drawings for quantity and exact locations of all fire extinguishers and cabinets.

1.2 Related Requirements

.1 Mechanical General Requirements; Section 15010.

2. PRODUCTS

2.1 Rating of Hand Held Fire Extinguishers

.1 Provide hand held fire extinguishers rated in accordance with CAN4 S508-M83 and bearing ULC label.

2.2 Hand Held Fire Extinguishers

.1 FEX-1 - Multi-Purpose Dry Chemical - Pressure Type:
- .1 Description: ammonium phosphate, powder type, heavy duty steel cylinder, baked enamel finish, squeeze grip handle with positive on/off valve, hose and nozzle, mounting brackets.
- .2 Capacity: 4.5 kg.
- .3 ULC Rating:(4A:60BC)
- .4 Classification: Class A, B, and C fires.
- .5 Wall Hung

2.3 Fire Extinguisher Cabinet

.1 Fire Extinguisher Cabinet: shall be by National Fire Equipment Ltd. Model CE-950-1 semi recessed with glass door for 100 mm deep wall in finished areas.

.2 Wall hung in unfinished or service areas.

3. EXECUTION

3.1 Installation

.1 Install fire extinguisher cabinet with top of cabinet 1.5 m above floor.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Cleanouts.

.2 Water hammer arrestors.

.3 Floor, roof, parking and planter drains.

.4 Sumps, catch basins and manholes.

.5 Backflow preventers.

.6 Trap primers.

.7 Pressure reducing valves

.8 Domestic water meters

.9 Domestic hot water storage tanks and heaters.

.10 Domestic water booster pumps.

.11 Domestic hot water recirculation systems.

.12 Hose bibbs.

.13 Storm water pump systems.

.14 Sanitary waste pump systems.

.15 Gas service connection and regulators.

1.2 Related Work Specified in Other Sections

.1 Roof construction details in Division 7.

.2 Excavation and backfilling Division 2.

1.3 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.

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

.4 Application and installation as required for gas, water, sanitary, storm services shall be made and paid for by the contractor.

.5 No horizontal piping shall be installed in masonry walls.

.6 Non-ferrous metals are to be used in high humidity areas.

.7 All covered parking area drains shall be to CSA Standards.

2. PRODUCTS

2.1 Cleanouts and Cleanout Access Covers

.1 Supply and install cleanouts on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack where drain leave the building; where shown on the drawings, 7.6 meters apart in horizontal drainage lines of 50mm and 65mm nominal diameter, 15.2 meters apart in horizontal lines of 75mm or 100mm nominal diameter and not more than 30 meters apart for larger pipe sizes and as called for in the National Plumbing Code.

.2 All outside cleanouts shall be extended to grade in cast iron. They shall be sufficiently anchored in a 300mm x 300mm x 100mm thick concrete block of concrete to prevent rotation of the pipe. Concrete work shall be provided and installed by the General Contractor.

.3 All cleanouts shall be full size for pipes up to 100mm diameter and 100mm size for larger pipes. Cleanouts shall be extended to a finished wall or floor. Cleanouts shall not terminate in the floor of any sterile rooms.

.4 The piping shall be extended beyond the room for cleanout installation. Where cleanouts occur in carpeted areas, they shall be extended to the finished walls unless the Consultant gives special permission for them to terminate the carpeted floor. In potentially wet areas such as washrooms, cleanouts shall be extended to the walls wherever possible. Where conditions do not permit wall cleanouts, the cleanout cover shall be waterproof, Zurn-ZN1602 with N.B. frame and cover and with integral waterproofing clamping collar. All cleanouts passing through walls or floors with a waterproofing membrane shall have a clamping collar which shall be clamped to the membrane.

.5 Cleanouts for copper pipe shall be cast brass, Crane 1816, 1817 or Emco 57-18190 with raised shoulder on plug and gasket.

.6 Cleanouts for cast iron pipe shall be steel plug type, Associated Foundry.

.7 Cleanouts for weeping tile - plastic pipe shall be Zurn Z-1402 with heavy duty top and vandal proof screws.

.8 Cover for cleanouts shall be as follows:

.1 Unfinished areas, such as concrete floors in equipment rooms and flush type C.O. in outside areas, Zurn ZX 1612 with cover suitable for heavy traffic.

.2 Slab on grade finished in ceramic tile Zurn-ZN1400-Z with N.B. frame and cover.

.3 Upper floors finished in ceramic tile, Zurn-ZN1400-Z with N.B. frame and cover.

.4 Floors finished in lino or other such thin material Zurn-EN-1608 or ZANB-1460-14 round or ZANB-1460-11 square with N.B. frame and cover.

.5 Walls finished with ceramic tile, Zurn AN 1445-4 with N.B. frame and cover, 250mm x 250mm.

.6 All painted walls, provide prime coated covers as specified for access panels with minimum clear opening of 200mm x 200mm for cleanouts 50mm and smaller 300mm x 300mm for cleanouts larger than 50mm. Avoid covers on feature walls; ie: wood panels. If unavoidable, the covers shall be for painted walls but with finish material secured to the cover to the satisfaction of the Consultant and finished flush with wall. In all sterile areas provided stainless steel finish on all access panel. All cleanouts shall have locations clearly indicated. Acudor UF-500, Acudor FB-5060 fire rated.

.9 All barriers for cleanout plugs shall be securely anchored so that they do not rotate when plug is being removed.

2.2 Water Hammer Arrestors

.1 Install stainless steel bellows type water hammer arrestors on water lines connected to groups of fixtures, flush valves, and all quick-closing devices, at top of all risers and install complete with accessible isolation valve. Water hammer arrestors shall be Zurn Z1700 series or approved equal.

2.3 Floor Drains

.1 Flow Characteristics: Full open flow unless noted otherwise. Check all construction details prior to ordering drains and ensure the drains are suitable for the construction.

.2 FD-1: Zurn Model ZN-415-B Duracoated cast iron body, epoxy coated aluminum clamp collar, polished nickel bronzed strainer with grate and complete with P trap primer connection.

.3 FD-2: Parking area drains shall meet CSA requirements with respect to type and location. Zurn Z-610-HY or equal square top drain, cast-iron body, seepage pan, membrane clamp, heavy duty iron hinged grate, and sediment bucket.

.4 FD-3: Zurn Model ZN-415-BF Duracoated cast iron body epoxy coated aluminum clamp collar and ZN-400-BF circular adjustable strainer with oval funnel complete with P trap primer connection.

2.4 Roof Drains

.1 Material: All major components including body, flashing clamping flange, under deck clamp dome strainer shall be cast iron or cast aluminum, lacquered. Bolts shall be galvanized. Dome may be rigid secured plastic where specified or prior approval and shall be a natural colour such as black or grey.

.2 Provide roof/area/planter drains appropriate for each application.

.3 All roof drains shall be with underdeck clamp and extension collars as required to suit roof construction. This contractor shall verify roof construction details and order roof drains accordingly at no additional cost to the contract.

.4 All drains shall be reviewed and accepted by the roofing inspector prior to ordering.

2.5 Trench Drains

.1 TD-1: ACO Model K100S - Pre-formed fibreglass body, 1% sloped, 100mm wide, Class C galvanized steel, slotted grate.

2.6 Sumps

.1 Reinforced concrete sumps by Division 3 sized as per drawings shall have necessary drainage fittings, 10 mm checked steel plate flush covers with gasket seal frames and anchor bolts.

2.7 Backflow Preventer

.1 Construct to AWWA requirements c/w test cocks as required and service repair kits.

.2 Size as per drawings.

.3 Zurn 950 Series: Double check valve assembly.

.4 Zurn 975 Series: Reduced pressure assembly.

2.8 Trap Primers

.1 Primers shall be Zurn 1022A type automatically activated connected to nearest cold water line and piped to traps. All p-traps which do not receive duty flow shall be provided with p-traps.

2.9 Pressure Reducing Valves

.1 Each station shall be complete with PRV's, globe valve by-pass, valves and pressure gauges. All to the National Plumbing Code Requirements.

2.10 Meters

.1 Each meter station and remote reader wheel required shall be to local municipality requirements using meter manifold to municipality or owners requirements. Meters shall be required for full range of flow.

2.11 Domestic Hot Water Storage Tanks and Heaters

.1 Construct gas fired domestic hot water heaters to CSA B140.12.

.2 Tank to be constructed in accordance with Section IV of the ASME code and shall have National Board of Boiler and Pressure Vessel inspection and be Underwriters' Laboratories listed. Tank shall be insulated and provided with an access.

.3 All pressure tanks shall meet the Alberta Boiler Inspector's requirements.

.4 All domestic hot water storage tanks and heater systems shall be complete with expansion tanks when in excess of 500 gallons.

.5 See schedules for sizes.

2.12 Domestic Water Booster Pump Station Dual Pump Package

.1 Provicde and install a dual pump packaged booster system. The system shall be as an integral unit ready to receive suction and discharge piping and incoming power supply.

.2 The pumps shall be suitable for 1725 kPa working pressure, bronze fitted, single stage, close coupled vertical in-line centrifugal type with drip-proof squirrel-cage induction motors suitable for operation on a supply of 208 volts, 3 phase, 60 cycles.

.3 The pumps shall be complete with gate valves, non-clam check valves, combination pressure reducing valves on each pump, copper piping with lead free solder, pressure gauges, thermal bleed circuits, wiring, conduit and interconnecting pipework, neatly arranged and firmly supported by the frame of the unit.

.1 The control panel and system shall incorporate the following features:

.1 Nema 1 general purpose enclosure.
.2 Main disconnect switch interlocked with door.
.3 Fused circuit for each motor.
.4 Magnetic starters with three leg overloads for each pump.
.5 Current sensing devices.
.6 Selector switch for each pump.
.7 Time clock and hydro-pneumatic tank with pressure switch for intermittent operation.
.8 Control circuit transformer with fuse protection.
.9 Minimum run timers.
.10 Low pressure alarm light.
.11 Circuit breakers for each pump.
.12 High suction pressure cut-out switch.
.13 Electrical alternation.
.14 "Power On" indicating lights.
.15 Panel mounted pressure gauges - suction and discharge.
.16 Alternation of lag pumps.
.17 Pressure reducing valves.

.4 All components shall be assembled on a fabricated steel base plate with structural steel framework, adequately ribbed and braced to ensure rigidity. Rubber mounts shall be provided to isolate all pipework from the base plate assembly.

.5 The complete unit shall be tested, hydraulically and electrically at the manufacturer's works, prior to shipment. All control devices shall be pre-set to suit the actual job requirements.

2.13 Domestic Hot Water Recirculation System

.1 Provide and install an all bronze body recirculation pump complete with Aquastat control. Provide balancing cocks as required to balance entire system.

2.14 Hose Bibbs

.1 HB-1: Emco Model 102411 sediment faucet 20 c/w watts No. 8A non-removable hose bibb vacuum breaker.

.2 HB-2: Zurn ZN 1300 recessed non freeze wall hydrant with polished bronze face, galvanized casing and vacuum breaker.

.3 HB-3: Zurn ZN-1365 encased, non-freeze ground hydrant complete with 50mm connection, bronze casing, all bronze interior parts, bronze seat, replaceable seat washer, and non-turning operating rod with free-floating compression closure valve with 50mm connection.

2.15 Storm Water Pump Systems

.1 Refer to Section 15140 Pumps and schedules.

2.16 Sanitary Waste Pump Systems

.1 Refer to Section 15140 Pumps and schedules.

3. EXECUTION

3.1 Installation

.1 Bury outside water and drainage pipe minimum 2.7 metre or as shown on the drawings.

.2 Install cast iron connections from weeping tile to storm drainage system including backwater valve, and cleanout. Provide access for servicing of backwater valve.

.3 Provide and install valved connections on hot and cold water lines to each hot water tank complete with vacuum breakers on cold water make-up and temperature pressure relief valve.

.4 Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joints. Install cleanouts as required by the local authorities plumbing code.

.5 Install vacuum breakers or backflow preventers to AWWA standards on plumbing lines where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibbs and flush valves. All backflow preventers shall be installed at a maximum 1500mm above the floor or ground level.

.6 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.7 Where floor drains are located over occupied areas, provide waterproof installations.

.8 Install trap primer on all drains which do not receive water daily. Primers shall be installed in an area accessible for easy maintenance.

.9 Drainage lines shall grade at 1% slope unless otherwise indicated on drawings or required by code.

.10 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa.

.11 Install vacuum relief valve on any tank subject to back-siphonage.

.12 All R.P. device bacfklow preventors shall be provided with daylight type drainage or full flow piping drain line or sump.

.13 Do not run any wet piping through electrical machine rooms or other similar rooms.

.14 Provide pump out drains in all elevator pits

.15 Provide dielectric fittings in all dissimilar metal connections.

.16 Coordinate types of drains (floor and roof) specified with building construction details.

.17 When connecting to existing sanitary and storm systems check inverts prior to commencing work.

3.2 Service Connections

.1 Extend new sanitary and storm sewer services from 1 meter outside building. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with sufficient slope for drainage and adequate cover to avoid freezing.

.2 Extend new water service connections from 1 meter outside building complete with valves, backflow preventors, water meter and by-pass valves. Provide necessary reinforced concrete thrust blocks on underground water piping as required. Provide sleeve in wall or floor for service main and adequately support at wall or floor with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Securely anchor service main inside to concrete wall.

.3 Provide new gas service complete with gas meters and regulators. Provide regulators and pressure reducing valves on each line servicing gravity type appliance, size in accordance with equipment. (These regulators are in addition to normal controls.)

3.3 Excavation and Backfilling

.1 Provide any excavations necessary for the installation of the mechanical work. No cutting, boring or excavating necessary for this work in or about the building which may cause interference with the progress of the work or weaken the structure in any way, shall be undertaken without the approval of the Consultant before commencing work. Trenches or tunnels for all underground piping shall be excavated to a depth slightly more than required and graded so as to secure all available fall. Support each length of pipe with concrete blocks and bricks, or backfill the trench with gravel to the required depth and grade. Sanitary and storm lines outside of the building shall be kept as deep as practical. See Section 02200 for excavation requirements.

.2 Backfilling in all trenches shall be with sand or pea gravel where approved, 150 mm below pipe and up to 150 mm over top of piping, then flushed with water so as to ensure the total length of each pipe is resting on solid footing. Remainder

of all trenches shall be filled by the General Contractor. See Section 02200 for backfilling requirements.

.3 Where sewer, water or storm pipes pass under a grade beam or footing the trench around the piping up to and in contact with the footing, provide a 450 kg concrete grouting so as to seal the outside trenching from normal storm runoff and backflow of rain water through the trenching and into the crawl space and/or under the basement floor.

.4 Where sewer, water or storm pipes pass through exterior walls below grade, the General Contractor shall install corbels on the exterior walls and run bridging from corbel to undisturbed soil for the support of the pipes. One inch thick waterproof mastic shall be applied around the pipes which pass through the wall.

.5 Repair concrete walls, pavement, walks, louvres, etc., where these have been damaged by the mechanical contractor.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Plumbing fixtures and trim.

1.2 General Requirements

.1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces, clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be products of one manufacturer. Fittings of same type shall be product of one manufacturer.

.4 Protect fixtures and trim against use and damage during construction.

1.3 Job Conditions

.1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Advise consultant of discrepancies prior to ordering fixtures or trim.

2. PRODUCTS

2.1 Laundry Valve – LS-1

.1 Encased washing machine valve, hot and cold hose connections, standpipe.

2.2 Service or Mop Sinks – MS-1

.1 Bowl: 900 X 600 X 250 mm deep white moulded stone, floor mounted sink with 25 mm wide shoulders, SS strainer (Zurn 2600).

.2 Trim: Exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose and spout, strainers, eccentric adjustable inlets, integral Zurn Z-1996-36-SF-MH-HH 1.5 m of 15 mm plain end reinforced rubber hose, hose clamp, mop hanger.

3. EXECUTION

3.1 Installation

.1 Install each fixture with its own threaded chrome plated for all sinks trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures, P-traps and equipment.

.2 Provide chrome plated rigid at wall with flexible risers or supplies to fixtures with screwdriver stops, reducers and escutcheons. Sinks to have minimum 375 mm long flexible risers.

.3 Install wall mounted lavatories, urinal, water closets, etc. with approved wall carriers, model to suit installation.

.4 Solidly attach floor mounted water closets to floor with lag screws.

.5 Install hose end faucets and hose connections with vacuum breakers.

.6 All toilets shall be complete with flange, wax seal, bolt caps, etc.

.7 Provide silicon caulking between finished walls and horizontal surfaces of water closets, urinals, lavatories and janitor sinks, etc. Sealant shall be a continuous smooth with a beveled watershed, sealant shall be mildew/algae resistant.

.8 All counters and sinks shall be drilled to suit the specified trim for each sink.

.9 Sinks shall not be used to clean paint brushes, trowels, etc. Do not dispose construction waste down any plumbing fixtures.

.10 All trim and plumbing fixtures shall be located as per the Architectural Details.

.11 All bathtubs and shower bases shall be provided with slip resistant surface regardless of units specified.

.12 All mixing vales shall be c/w check stops.

.13 All wheelchair toilets shall have flush valve handles located on the side of the flush tank or flush valve where the wheelchair parks.

.14 All waste arms from traps shall be mechanical joint to risers not soldered.

.15 Provide hangers to support all p-traps which are larger than 50 mm in size.

3.2 Fixture Service Connections

.1 Provide individual fixture pipe connections in accordance with the following table of minimum sizes or as required for particular fixtures.

	Hot Water	Cold Water	Waste	Vent
Lavatories	12 mm	12 mm	30 mm	30 mm
Service Sink	12 mm	12 mm	50 mm	40 mm
Kitchen Sink	12 mm	12 mm	40 mm	30 mm
Drinking Fountain	-	12 mm	30 mm	30 mm
Water Closets (Flush Valve)	-	40 mm	100 mm	50 mm
Water Closets (Tank Type)	-	12 mm	100 mm	50 mm
Urinals (Flush Type)	-	40 mm	50 mm	40 mm
Urinals (Tank Type)	-	12 mm	50 mm	40 mm
Floor Drains	-	-	100 mm	40 mm
Hose Bibbs	18 mm	18 mm	-	-

END OF SECTION

1. GENERAL

1.1 Scope

.1 Provide for cleaning and degreasing of all systems that use water as a heat transfer medium.

.2 Provide for cleaning and disinfection of domestic hot and cold systems.

.3 Provide all temporary strainers, connections and by-pass lines as required.

.4 Provide equipment to add chemicals to the systems as specified herein.

.5 Provide equipment to operate and control the system as specified herein. Provide appropriate protection so that capped off unused piping does not corrode.

1.2 Quality Assurance

.1 The water treatment chemicals and treatment process shall be supplied and performed by the Contractor. This work shall be supervised by the Water Treatment Specialist, who upon completion, shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

1.3 Reference Standards

.1 Do HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.

1.4 Submittals

.1 Submit shop drawings including proposed chemicals, quantities, procedures and equipment to be supplied. Provide written operating instructions and system schematics.

.2 Provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.

.3 Submit written report containing test results and list of chemicals added every 14 days from time of commissioning to acceptance.

.4 Notify Consultant 48 hours prior to chemical cleaning so that work may be verified and reviewed.

1.5 Water Treatment Service

.1 The Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit a written report on system operations.

.2 The Water Treatment Specialist shall instruct the maintenance personnel before substantial completion. Written instructions of the treatment, dosages control charts and test procedures shall be included in the maintenance manuals.

.3 The Water Treatment Specialist shall provide monthly visits to check chemical treatment, take water samples and recommend any necessary changes to treatment, and provide a written report for a period of one year after substantial completion. Provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the building. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation.

2. PRODUCTS

2.1 Materials

.1 Closed System Cleaner: Use a neutral pH cleaning compound which in solution removes grease and petroleum products. Concentration level to be determined by Water Treatment Specialist. (Jacklyn - WM8588 or approved equal.)

.2 Closed System Corrosion (Hot Water, Chilled Water): Use a Borated Nitrite based corrosion inhibitor. Maintain levels at 900 to 1200 ppm nitrite. (Jacklyn WM 8676 or approved equal.)

.3 Domestic water system: Sodium Hypochlorite conforms to ANSI/AWWA B301.

.4 Materials which may contact finished areas must be colourless.

2.2 Equipment

.1 Closed System (Heating or Cooling)

.1 Bypass Pot Feeder: All closed hot water and chilled water systems shall have a by-pass chemical pot feeder with a 7.6 litre capacity. It shall be constructed of heavy duty cast iron or welded steel (suitable for 1380 kPa [200 psi] working pressure), with quick opening cap and complete with 20 mm NPT connections. Isolating valves shall be installed on the inlet, outlet and drain.

.2 Sidestream Filter: All closed hot water and chilled water systems shall have a sidestream filter housing of steel construction using a 250 mm x 10 micron filter cartridge, with a minimum flow rate of 35 litres/minute. A Flow Indicator with stainless steel impeller shall be installed in conjunction with the sidestream filter. Connections shall be 20 mm NPT and all isolating valves shall be installed as per manufacturer's instructions. Include 10 filter cartridges.

.3 Totalizing Make-up Water Meter: Cast Bronze body, 20 mm NPT connections, thermoplastic rotor and gear train, rated at 1206 kPa [175 psi] maximum operating pressure.

.4 Chemical Feed Piping:

.1 Schedule 40 black steel

.5 Corrosion Coupon and Holder Assembly:

.1 Mild steel corrosion coupon

.2 Holder, 20 mm or 25 mm NPT male connection.

.3 Provide malleable or cast iron cross, 20 mm or 25 mm NPT male connection.

3. EXECUTION

3.1 Pre-Operational Cleaning and Chemical Treatment

.1 All systems must be chemically cleaned and flushed before water treatment is added. This includes partial or complete filling for pressure testing.

.2 After all components of the piping system have been pressure tested and proven to be in full operational condition and leak free, flush entire system with fresh, clean make-up water to remove loose mill scale, sediment and construction debris.

.3 Provide drain connections to drain system in one hour. Install totalizing water meter to record capacity in each system.

.4 All drains for chemical treatment shall be piped to the nearest floor drain.

.5 After initial flushing has been completed, clean all strainer screens.

.6 System pumps may be used for cleaning, provided that pumps are dismantled and inspected, worn parts repaired with new gaskets and seals installed. Submit used seals.

.7 Add cleaner to closed systems at concentration levels recommended by the Water Treatment Specialist.

.8 For hot water heating systems, apply heat while circulating, raise temperature slowly to 70°C and maintain at 70°C for minimum of 12 hours. Remove heat and circulate at 40°C or less. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill system and immediately add water treatment to proper level.

.9 For chilled water systems, circulate for 48 hours. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill and immediately add water treatment to proper level.

.10 Use neutralizing agents upon recommendation of the Water Treatment Specialist and as approved by Consultant.

.11 Inspect, remove sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.2 Cleaning and Chlorination of Potable Water Piping

.1 All domestic water piping shall be thoroughly flushed so that it is free from scale, sediment, construction debris etc.

.2 On completion of installation and testing of the potable water systems, pre-flush, chlorinate with Sodium Hypochlorite to AWWA C-651-92 specifications and let stand for 24 hours. Thoroughly flush until water quality meets AWWA standards.

.3 Retain an independent testing firm to supervise and inspect the chlorination and flushing procedures and perform tests as required.

.4 Submit to the Consultant, a certificate from the testing firm, stating that the chlorination and flushing have been successfully carried out.

.5 Retain an independent laboratory to perform bacteriological test. Submit Certificate of Analysis to the Consultant.

.6 Acceptable Firms: PACE Chemicals Ltd., Betz Dearborn.

3.3 Test Kits

.1 Provide test kits to determine proper systems treatment, including but not limited to the following

.1 Closed System Test Kit: To determine proper level of Borated Nitrite and Molybdate in closed system treatment. (PACE Chemicals Test Kit # 104 or approved equal.)

END OF SECTION

1. GENERAL

1.1 Scope

.1 The wet and dry sprinkler systems shall include but not be limited to a complete automatic wet and dry system complete with all valves, sprinkler stations, tamper switches, pressure switches, piping, coring, sleeves, fittings, alarms, siamese connections, compressors, controls, sprinkler heads, sway bracing, hangers, test valve cabinets, and supports.

1.2 General Requirements

.1 Provide complete sprinkler systems as required by NFPA, Local Codes and as indicated on drawings. Size of sprinkler system is based on:

- .1 Residential Areas:
  - .1 Light Hazard
- .2 Parking Areas:
  - .1 Ordinary Hazard – Group I
- .3 Mercantile Areas:
  - .1 Ordinary Hazard – Group 2

.2 Provide sprinklers for areas as indicated and required including specialized rooms. Run piping concealed above ceiling and in joists and structure space to minimize obstruction. Co-ordinate all sprinkler piping and head locations with structure, piping, ductwork and lights. Coordinate sprinkler head locations with reflected ceiling plans.

.3 The fire protection fire sprinkler Contractor shall hydraulically calculate and size the fire sprinkler system to NFPA requirements and as noted herein. Piping runs as shown on the plans are to be adhered to as closely as possible. No deviations will be allowed unless approved by the Consultant or where required for coordination purposes. Drawings shall bear the stamp and signature of a Professional Engineer registered in the Province.

.4 Fire protection system pipe sizes are not in all cases shown on the drawings. This sprinkler Contractor shall size to Code and as noted. (Also size lines for future building expansion and provide calculations, when necessary.)

.5 When systems are sized all head and pipe locations must be coordinated with (existing and/or new) site conditions including architectural, mechanical, structural and electrical. Shop Drawings are subject to the Consultant's review.

.6 Where additional sprinkler heads are required to comply with Code or the Fire Marshall and other governing authority requirements, the Sprinkler Contractor shall add such heads all at no cost to the Owner.

.7 The Fire Sprinkler Contractor is required to submit, working drawings and calculations for review and acceptance by the Fire Marshall (and I.A.O.) prior to commencing the installation.

.8 Sprinkler head locations and type shall be shown on a plan prepared by the Sprinkler Contractor and submitted to the Consultant for review prior to installation. Sprinkler heads must be centred on panel tiles, etc., if additional heads are required to accomplish the desired symmetry. This Contractor shall

add heads as required and as directed or noted on the reviewed drawings without additional costs.

.9 The dry and wet sprinkler systems shall be hydraulically sized as follows:

.1 Information required will be as shown in NFPA #13, latest edition, plus a node schematic for looped or gridded systems, showing the direction of flow in each pipe length.

.2 To expedite the examination of hydraulically calculated sprinkler systems, the following information is to be submitted with the drawings and calculations for review:

.1 The direction of flow and the quantity flowing in each pipe leading to or in the design area chosen.

.2 The type of pipe and the C factor used for piping in the system and in the underground supply to the system in addition a "K" factor is required.

.3 A node diagram with indication of the discharge quantities from each sprinkler and the pressure applying at each node point.

.4 The quantity contemplated for internal and external hoses, fire hydrants, where applicable, and the point in the system at which this quantity is taken off.

.5 A supply and a demand curve at a common reference point (to be stated) on a semi-log graph paper to show the relationship between the sprinkler and hose demand against the actual supply. Provide a water supply capable of supplying 20% more in volume than the total sprinkler demand and 10% more pressure at the base of the riser. When water supply information is obtained from a third party, a copy of the written confirmation indicating the amount available, the pressure available, the reference point, the time and date of test and the person or persons who made the test.

.6 Hydraulically calculated sprinkler designs are not to include velocity pressures in the calculation.

.7 The maximum velocity permitted in piping in automatic sprinkler systems is 25 ft./sec.

.8 (In open space areas where future partioning or modifications such as in office buildings will occur the hydraulically sized main loop on each floor shall be increased by one pipe size to accommodate additional sprinkler heads at a later date).

.10 Water Supplies

.1 Water supplies shall be from city or municipal water system. It is the sprinkler Contractor's responsibility to obtain water pressures, flows, and local site and area water service information.

.2 Water supplies shall be adequate in pressure, volume and reliability.

.3 There shall be available for hydraulically calculated systems at least 110% of the calculated pressure at the base of the sprinkler riser. (In addition there shall be available at the connection to the local water main a hose allowance of 250 gpm, 100 gpm on light hazard). If a fire hydrant is on the same connection as the sprinkler feed the allowance shall be calculated from the point of take-off.

.11 Contractor's Certificate

.1 NFPA Testing Contractor's Certificate is to be completed and forwarded to the authority having jurisdiction and the Consultant as evidence that the necessary tests and materials have been provided. It is stressed that all sections of the certification are to be completed.

.12 Design Standards

.1 The entire installation shall conform to current standard, rules and regulations of NFPA Standard 13 and all other governing codes.

.2 Quick response sprinklers shall be installed at all landings in stairwells.

.3 The complex will be provided with complete automatic sprinkler protection designed to protect the various fuel loads present. Protection will be in the form of wet-pipe sprinkler systems, hydraulically designed in accordance with NFPA 13, "Standard for the Installation of Sprinkler Systems".

.4 Floor areas which are open to the exterior or unheated will be provided with dry-pipe sprinkler systems. A separate dry-pipe valve will be provided for each zone within these areas.

.13 Sprinkler Zones

.1 The sprinkler zones are designated on the fire protection drawings. All zones shall be coordinated with electrical and mechanical contract to ensure full annunciation at building fire panel. This contractor shall coordinate with Division 16. To properly locate and identify all zones on the buildings fire protection and annunciation graphics board.

1.3 Quality Assurance

.1 Sprinkler equipment and installation shall be in accordance with recommendations of Owner's Underwriters and approved by local Fire Commissioner. All products shall be ULC and U.L. approved.

.2 Sprinkler equipment shall be installed by qualified Contractor licensed and regularly engaged in installation of automatic fire sprinkler equipment. Where welding is used, the qualification of the welder, quality of welds and materials shall be documented for review by the Consultant and municipal authorities.

.3 Equipment and installation shall meet the requirements of NFPA No. 13 - Standards for the Installation of Sprinkler Systems.

1.4 Submittals

.1 Submit layout showing only head type, head and piping locations for review by the Consultant. Furnish additional heads which may be required for a coordinated ceiling pattern without added cost, even though the number of heads shown may exceed minimum code requirements. Identify extent of earthquake protection on submittals.

.2 Shop drawings and hydraulic calculations for the entire sprinkler system shall be submitted to the Fire Authorities (and IAO and Insurance Underwriters) for approval prior to submission to the Consultant for review. Submit a sample of each type of sprinkler head used. Submit only approved drawings to the Consultant.

2. PRODUCTS

2.1 Sprinkler Heads

.1 Temperature rating on fusible links shall suit specific hazard area and all Central "Omega" sprinkler heads shall be silicon gaskets only..

.2 In parking areas and other dry system areas use Central Model A upright brass sprinklers.

.3 In areas subject to freezing use Central Model H-1, non freeze sidewall heads or Central Model A-1 dry pendant heads connected to wet sprinkler systems.

.4 In elevator machine rooms and electrical rooms, the sprinkler heads shall be on-off type with 80□C to 110□C temperature rating and c/w wire guards.

.5 For all other sprinkler head types and requirements refer to manufacturer information regarding sprinkler head type, location and suitability for each project. For example:

.1 Is project under F.M. rules or not if so all heads; equipment must be F.M. approved, this limits your equipment selection opportunities
.2 UL or ULC
.3 Extended coverage (area coverage)
.4 Quick response
.5 Occupancy Hazard
.6 Architect's requirements
.7 Owners requirements
.8 Residential type Versus Commercial
.9 Window wash type
.10 Central "Omega" style sprinklers not permitted

.6 Note 3.1 Installation for special sprinkler requirements.

2.2 Sprinkler Valves

.1 Provide approved automatic sprinkler valve stations Wet and Dry as required, c/w flow detectors, pressure or flow switches, outside alarm bell, excess pressure pump and air compressor.

.2 Provide and install wet sprinkler zone stations as shown on the drawings. Each station shall consist of Victaulic Testmaster Style 718 alarm test Module, drain, flow switch, pressure regulating type OS&Y control valve c/w tamper switch and the entire unit shall be accessible for test purposes and secured tight to walls (or provided inside a fire hose cabinet with full metal door). Provide full sized piped drain systems to safe drain location from all alarm test modules.

.3 All valves on connections to water supplies and on supply pipes shall be approved indicating valves, unless a non-indicating valve, such as an underground gate valve with approved roadway box complete with T-wrench is accepted by the authority having jurisdiction.

.4 All valves on fire protection systems shall be U.L. or ULC approved. F.M. where required.

.5 Valves shall be provided as shown on the drawings and as required by current NFPA-13 Edition.

.6 Such valves shall close in not less than five (5) seconds when operated at maximum possible speed from the fully open position.

.7 All control valves shall be complete with monitor switches on both regular and emergency power.

.8 An approved check valve shall be installed in each fire department connection, located as near as practicable to the point where it joins the system or as shown on the drawings.

.9 When there is more than one (1) control valve, identification signs indicating the portion of the system controlled by each valve should be provided.

.10 A pressure gauge shall be installed on the riser or feed main, at or near each test pipe, with a connection no smaller than 6 mm. This gauge connection shall be equipped with a shut-off valve and with provision for draining. Gauges shall be provided with snubbers.

.11 The required pressure gauges shall be of approved type and shall have a maximum limit not less than twice the normal working pressure at the point where installed. They shall be installed to permit removal, and shall be located where they will not be subject to freezing.

.12 All pressure and flow switches shall be supplied and installed by Division 15 and wired by Electrical Division 16 back to the electrical fire alarm system as shown on the electrical drawings. Flow switches shall be U.L. listed and approved for standpipe and sprinkler systems (20-second time delay), double pole, double throw (DPDT) type, c/w one normally open and one normally closed set of contacts. All switches shall be on both regular and emergency power.

.13 The sprinkler system main water supply shall be provided and installed by Division 15 with a pressure switch to indicate low pressure and shall be wired by Division 16 to the fire alarm system.

2.3 Wet Sprinkler Pipe Valve Station

.1 Wet pipe valve shall incorporate all component requirements of NFPA, and all other governing authorities.

.2 Pipe main drain valve to outdoors and discharge away from entrance or exit doors, conceal piping.

.3 Pipe drip cup to the floor drain. Division 16 shall wire all motors, flow switches and tamper switches.

2.4 Dry Sprinkler Pipe Valve Station

.1 Dry pipe valve shall incorporate all component requirements of NFPA, and all other governing authorities.

.2 Pipe main drain valve to outdoors and discharge away from entrance or exit doors.

.3 Dry pipe valve alarm station assembly shall be complete with air compressor, ULC approved, excess pressure device, accelerator, starter, motor, disconnect valves, pressure gauges, electric alarm and water motor gong, all controls, etc., complete to NFPA standards. Division 16 shall wire all motors, switches, etc.

2.5 Excess Pressure Pump

.1 Provide pump capable of pumping sprinkler system to 280 kPa in excess of normal pressure with supports, gauge, starter and connection to sprinkler system.

2.6 Air Compressor

.1 Provide electric drive, horizontal tank mounted, single stage compressor, capable of restoring normal system air pressure within 30 minutes, two pole air pressure operated electric pressure switch with 2-way release or breather valve, safety valve, check valve, tank drain, belt guard and controls. Air compressor shall be on emergency power.

3. EXECUTION

3.1 Installation

.1 Protect sprinkler heads against mechanical injury with standard guards where necessary.

.2 Locate outside alarm on wall of building adjacent to Siamese fire department connections. Siamese fire department connections shall be located on address side of building unless otherwise approved by the local authorities.

.3 Provide on sprinkler system take-off from water supply on U.L. approved double check valve assembly with monitored OS&Y gate valves on each side of check valves.

.4 Install approved monitored valves and flow switches for all zones. Monitored valves and flow switches shall be wired to central fire alarm system by Division 16. Identify each valve by indicating which portion of the system is controlled by each valve.

.5 All sprinkler head locations shall be coordinated with the lighting, audio equipment, and all other obstacles on the ceilings.

.6 Adjust sprinkler piping up or down if conflictions occur between structure, lighting, electrical, plumbing piping or ductwork.

.7 Provide and install accelerators or exhausters on the dry pipe valve stations to ensure water flow to each system at most remote location within 60 seconds.

.8 At each capped-off wet sprinkler location shown on the plans provide and install two bolted flanges with threaded female connection. Behind each cap-off there shall be installed a metal Blank and full gaskets punched for bolt holes. The metal Blank shall have a tab with 6 mm hole in tab for wire hanger connection. The metal Blank shall be fitted between the two bolted flanges and gaskets and made watertight. Bolted flanges shall be installed clear of ducts and other equipment.

.9 Provide 25 mm diameter nipple and 25 X 15 mm reducing fitting for each upright head.

.10 Install approved monitored alarm valves and flow switches for all zones. Alarm valves, tamper switches, and flow switches shall be wired to centre alarm panel by electrical contractor.

.11 Arrange piping routing to provide sufficient access to mechanical and electrical equipment.

.12 A wrap around hanger or other approved means shall be provided at the end of each branch sprinkler line to prevent excessive movement.

.13 Drop in inserts are not permitted. Use wedge type anchors or those indicated in Section 15090.

.14 The built in vertical adjustment on sprinkler heads shall not be used so that all nipples are the same length and the piping grade is achieved by having various non uniform sprinkler head depths with respect to the escutcheons. All heads and cups shall be uniform in depth and elevation.

.15 ***Do not*** install any sprinkler heads until all piping systems have been flushed of all contaminants such as cutting oil.

.16 Provide wire guards on all sprinkler heads subject to damage, ie. closets, mechanical rooms, equipment rooms, etc.

.17 Provide dry pendant or sidewall heads on all wet sprinkler systems with heads piped into cold areas.

.18 Provide sprinkler heads in all elevator pits and at top of elevator shafts.

.19 Provide breakaway sprinkler heads in all areas subject to damage such as security areas, prisons and psychiatric cells.

.20 All off site prefabrication of sprinkler piping shall be at the contractor's own risk.

3.2 Testing

.1 All tests required by this standard for the work shall be performed by this Contractor. When the authority having jurisdiction desires to be present during the conduct of tests, the Contractor shall give the authority having jurisdiction advance notification of time tests to be performed.

When the representative of authority having jurisdiction is not available and permission is granted by that authority, tests may be witnessed by the Owner or his representative and the Contractor's material and test certificate as per NFPA standards shall be completed and forwarded to the authority having jurisdiction.

.2 The sprinkler system is subject to final inspection test, and approval by the Fire Marshall and Consultant.

.3 Before requesting approval and acceptance testing of the equipment by the Fire Marshall, the installing company shall furnish a written statement to the effect that the work covered in this installation has been completed and tested in accordance with the approved plans and specifications, and shall provide a "Contractor's Material and Test Certificate" as required by the NFPA Standard No. 13, General Information.

.4 All systems and piping shall be tested hydrostatically at not less than 1380 kPa pressure for two (2) hours, or at 345 kPa in excess of the maximum static pressure when the maximum static pressure is in excess of 1030 kPa.

.5 The hydrostatic test pressure shall be measured at the low point of the individual system or zone being tested.

.6 The inside piping shall be installed in such a manner that there will be no visible leakage when the system is subjected to the hydrostatic pressure test.

.7 Provide flushing connections on all sprinkler systems.

.8 Piping between the check valve in the fire department inlet pipe and the outside connection shall be tested the same as the balance of the system.

.9 Brine or other corrosive chemicals shall not be used for testing systems.

.10 No substance to stop leaks shall be introduced to any sprinkler system.

3.3 Final Approval

.1 Before asking final approval of the automatic dry and wet sprinkler system by the authority having jurisdiction, the installing company shall furnish a written statement to the effect that the work covered by its contract has been completed and tested in accordance with the approved specifications and plans.

.2 Contractor's Certificate - NFPA Contractor's Test Certificate is to be completed and forwarded to the authority having jurisdiction and the Consultant as evidence that the necessary tests and materials have been provided. It is stressed that all sections of the certificate are to be completed.

.3 There shall be maintained on the premises a supply of spare sprinklers (never less that six (6)). These sprinklers shall correspond as to types and temperature ratings with the sprinklers in the property. The sprinklers shall be kept in a cabinet. The cabinet shall be located in the mechanical room.

.4 A special sprinkler wrench shall also be provided and kept in the cabinet, to be used in the removal and installation of sprinklers.

.5 The stock of spare sprinklers shall be as follows for each type of sprinkler head used on the project:

.1 For systems not over 300 sprinklers, not less than six (6) sprinklers.
.2 For systems 300 to 1,000 sprinklers, not less than twelve (12) sprinklers.
.3 For systems above 1,000 sprinklers, not less than twenty-four (24) sprinklers.

END OF SECTION

1. GENERAL

1.1 Scope

.1 The wet standpipe system shall include but not be limited to a complete system with all valves, pumps, electrical connections, flow switches, valves, tamper switches, hose cabinets, siamese connections, test headers, piping, fittings, alarms, controls, sleeves, sway bracing, hangers, supports and valved roof hydrants.

1.2 General Requirements

.1 Provide inside and outside piping including valves, fire hose cabinets, hangers and supports, fire department connections.

.2 Provide portable hand fire extinguishers and cabinets of type and size indicated on drawings and specified in Section 15380.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be in accordance with recommendations of Owners Insurance Underwriters and approved by local Fire authorities. All products shall be U.L.C., U.L. approved subject to owner's insurance underwriters.

.2 Equipment and installation shall meet the requirements of NFPA No. 14 - Standards for the Installation of Standpipe and Hose Systems and NFPA No. 20 installation of fire pumps.

1.4 Submittals

.1 Shop drawings for the entire standpipe systems shall be submitted to the applicable municipality and owner's insurance underwriters for approval prior to submission to the Consultant for review.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers

.1 Refer to Section 15380 for further requirements.

2.2 Fire Department Valves

.1 65mm chrome plated cast or forged brass with local fire department thread brass, cap and chain.

2.3 Siamese Fire Department Connection

.1 Provide two-way flush mounted siamese fire department connection with chrome plated finish, local fire department thread, dust caps and chains, 20 mm automatic drip marked "Standpipe - Fire Department Connection".

Note: If siamese on standpipe is used for a combined system then lettering shall read "Comb. Wet Sprinkler/Standpipe".

2.4 Fire Pump

.1 Provide and install one only packaged fire pump system. U.L. approved, vertical split case fire pump coupled to and driven by a 3600 rpm, 208/3/60 electrical motor. Maximum working pressure of 1785 kPa. Pump shall be complete with discharge flange, suction and discharge gauges, air release valve and bypass relief valve. Provided with the unit shall be a full service reduced voltage fully automatic U.L. approved fire pump controller.

.2 Provide and install one jockey pump coupled to and driven by a 208/3/60, 3600 rpm electric motor. Jockey pump shall be complete with C.S.A. approved controller, starter, and inlet and discharge pressure gauges.

.3 Provide and install one only UL/FM approved fire pump flow meter with Annubar and accessories.

3. EXECUTION

3.1 INSTALLATION

.1 Install hose valve at maximum 1.5 m above floor.

.2 Make connections for standpipe system before domestic water connections including meter.

.3 Provide on standpipe take-off from water supply on approved double check valve assembly U.L. approved c/w with monitored OS&Y valves on both sides of check valves to AWWA requirements.

.4 During construction, make one standpipe outlet available on each floor without delay, for fire department use.

.5 Where the static pressure exceeds 690 kPa at hose cabinets or fire department valves, provide pressure reducing type valves to prevent pressure on hose exceeding 620 kPa.

.6 Provide pressure gauge at top of each standpipe rise.

.7 Provide shut off valve at base of each standpipe.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Firestopping at penetrations through fire rated walls and floor assemblies, other than mechanical system penetrations: Section 07270.

1.2 Work Included

.1 Furnish all labour, material, equipment and services necessary to supply and install firestopping and smoke seals around mechanical service piping and duct penetrations through fire rated wall and floor assemblies.

1.3 Quality Assurance

.1 The work of this section shall be carried out only by an approved specialist firm, employing skilled tradesmen experienced in firestopping and smoke seals application.

.2 All work to be of the highest quality according to best trade practice and in strict accordance with manufacturer's printed specifications.

1.4 Samples

.1 Submit samples of each type of firestopping, smoke seal and accessories to the Consultant prior to commencing firestopping work on site.

1.5 Shop Drawings

.1 Submit shop drawings and product data in accordance with Section 01300, Submittals.

.2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.

.3 Submit manufacturer's product data for materials and prefabricated devices. Provide descriptions which are sufficient for identification at job site. Include manufacturer's printed installation instructions.

1.6 Product Delivery, Storage, and Handling

.1 All materials shall be delivered and stored in original wrappings and containers with manufacturer's seals and labels intact and as recommended by the approved manufacturer.

.2 Protect materials from environmental conditions as required by manufacturer's recommendations.

.3 All materials are to arrive on site pre-mixed

1.7 Job Conditions

.1 Conform to manufacturer's recommended temperatures, relative humidity and substrate moisture content for application and curing of firestopping materials.

.2 Protect all work against damage and disfiguration by other trades, and protect work of other trades against soiling and damage arising out of this work.

.3 At completion, replace and/or repair any defective work to the satisfaction of the Consultant.

2. PRODUCTS

2.1 Materials

.1 Firestopping and Smoke Seal Systems: Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases as tested in accordance with the requirements of CAN4-S115 (latest edition).

.2 Firestopping shall not exceed opening sizes for which they are tested.

.3 Firestopping System Ratings shall be FTH.

.4 Service Penetration Assemblies shall be certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19 or UL 1479 and ASTM E-814.

.5 Fire resistance rating of installed firestopping assembly shall be not less than fire resistance rating of surrounding floor and wall assembly.

.6 Approved Manufacturer shall be: Firestop Systems Inc. or approved alternate.

.7 Primers: To manufacturer's recommendation for specific material, sub-state and end use.

.8 Water (If Applicable): Potable, clean and free from injurious amounts of deleterious substances.

.9 Damming and back-up Materials, Supports and Anchoring Devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

.10 Sealants for Vertical Joints: Non-sagging.

.11 All smoke seal materials shall have been tested in accordance with CAN/ULC S102 Standard Method of Testing for Surface Burning Characteristics of Building Materials and Assemblies and have a flame spread classification of 25 or less.

.12 All firestopping and smoke seal materials that will come directly in contact with plastic pipe shall have undergone material compatibility testing by the manufacturer and/or the pipe manufacturer.

.13 Where moisture seals are required for floor penetrations in Operating Rooms, Morgues and Laboratories in Hospitals, Universities and Schools, the firestopping

material selected must be compatible with Formalin (37% formaldehyde/63% methanol).

.14 All firestopping material and smoke seals shall have elastomeric characteristics to allow for building settling and movement.

.15 All firestopping material and smoke seals shall be free of Asbestos.

.16 Firestopping systems must be install in accordance with the listed system design limitations unless a technical evaluation is approved by an acceptable third party testing agency.

.17 All listed system designs used must provide and Flame (F), Temperature (T) and Hose Stream (H) rating in accordance with those outlined in the most recent National Building Code (NBC) including any additional requirements noted in this Section.

3. EXECUTION

3.1 Inspection

.1 Inspect all surfaces to be firestopped, prior to commencement of the Work. If any unsuitable or unsatisfactory conditions are found, submit written report to the Contractor.

.2 Starting work shall be interpreted as acceptance of all conditions and surfaces.

.3 Municipal Inspection Authorities to be contacted for approval of all firestopping material and installation prior to application of wallboard.

.4 Notify Consultant (Engineer) when ready for inspection and prior to concealing or enclosing firestopping materials and service penetration assemblies.

3.2 Preparation

.1 Examine sizes and conditions of voids to be filled to establish correct thickness and installation of materials. Ensure that substrates and surfaces are dry and frost free.

.2 Clean and prepare surfaces in contact with firestopping materials and smoke seals to manufacturer's instructions.

.3 Maintain insulation up to fire separation around pipes and ducts penetrating fire separation.

.4 Prime surfaces in accordance with manufacturer's instructions.

.5 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 Installation

.1 Install firestopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions to provide a flame, temperature

and hose rated seal not less than the fire resistance rating of the surrounding wall or floor assembly.

.2 Install to formed, sleeved or cored mechanical service penetrations in fire rated wall and floor assemblies.

.3 Seal holes or voids made by penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure that the continuity and integrity of fire separation is maintained. Minimum thickness of sealant shall be 12 mm.

.4 Annular space in pipe sleeve not to exceed manufacturer's directions.

.5 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

.6 Tool or trowel exposed surfaces to a neat finish.

.7 Remove excess compound promptly as work progresses and upon completion.

.8 In all firestopping systems that require mineral wool or ceramic fiber backer or filler materials, the materials must be dry and free of contaminants before, during and after installation of fire stopping material. Alkaline water contamination of the backer of filler material may cause corrosion of metallic penetrating items.

.9 Firestop and smoke seal all gaps and holes in fire separations and firewall construction through which ductwork, piping, and all other mechanical protrusions pass, as a result of the Work, with the appropriate listed system design identifying substrate type , penetrating material type, penetrating item size, minimum and maximum annular space and overall FTH ratings.

.10 Apply firestopping system at unpenetrated openings and sleeves installed in fire separations and firewalls for future use.

.11 Install 1/4" to 3/8" bead of firestopping at interface of retaining angles around fire and smoke dampers, where angles meet fire or smoke rated assemblies, and between retaining angles and fire damper on both side of penetration. At floor location, apply bead to the top of the assembly.

.12 Where necessary, remove fiberglass insulation from insulated pipes and ducts and replace with mineral wool insulation, where these services penetrate a fire separation or fire wall unless the listed system design permits such insulation to remain within the firestopping system.

.13 Where the bottom of the firestopping system is exposed, seal bottom side of the assembly with a fire rated elastomeric firestop sealant.

3.4 Curing

.1 Cure materials in accordance with manufacturer's directions.

.2 Do not cover up materials until proper curing has taken place.

3.5 Clean-Up

.1 Remove excess materials and debris and clean adjacent surfaces immediately after application.

.2 Remove temporary dams after initial set of firestopping and smoke seal material.

3.6 Firestop Testing

.1 5% or a minimum of 4 completed penetrations in fire or smoke walls shall be disassembled in the presence of the consultant.

.2 Should fire stopping prove inadequate, an additional 5% of the penetrations shall be disassembled in the presence of the consultant..

.3 Contractor shall assume all costs for re-installation and/or repair of rejected firestopping.

3.7 Smoke Testing

.1 Perform simulated smoke tests at locations selected by the Consultant.

.2 The simulated smoke agent shall be non-toxic, non-staining and shall provide a heavy fog at 80 mg/m^3 with a permissible airborne level concentration of 50 ppm

.3 Simulate smoke at a rate of four seconds/2.8 cubic metres and maintain the fog density until inspection is complete.

.4 Should any penetration, joint or void under the jurisdiction of this section emit visible simulated smoke, repair and replace deficiencies and re-perform the simulated smoke test at no additional cost to the Owner.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Boilers.

.2 Controls and boiler trim.

.3 Hot water connections.

.4 Fuel connection.

.5 Electrical power supply.

.6 Collector, draft hood and chimney connection.

1.2 Quality Assurance

.1 Comply with Provincial Regulations and have CSA and CGA approval.

.2 Units shall be approved and labelled by Underwriters' Laboratories.

1.3 Start-Up

.1 Provide start-up service and provide report, make adjustments and efficiency tests, and instruct operators.

.2 Provide maintenance and operating instructions to Owner's designated representatives.

2. PRODUCTS

2.1 Type

.1 Provide hot water boiler with insulated jacket, heat exchanger, gas burning system, refractory, controls and boiler trim.

2.2 Construction

.1 Provide a packaged and assembled finned tube type of boiler with CGA approval designed to ASME Code for a working pressure of 1120 kPa.

.2 Provide steel or copper tube heat exchanger with finned tubes.

.3 Gas burner shall be raised round port stainless steel for natural gas firing with removable drawer.

.4 Provide insulated steel jacket with baked enamel finish. Provide flue connection.

2.3 Boiler Trim

.1 Provide Tridicator operating aquastat, high limit, T & P relief valve, flow switch and McConnell Model No. 902M or equal.

.2 Provide 24 volt transformer for controls. Controls and safeties shall be pre-wired.

.3 Provide firing control with electronic ignition with on/off, high/low, or fully modulating firing as called for in the schedules.

.4 Provide local control panel, refer to controls sequence of operation.

2.4 Fuel Burning System

.1 Gas Burner: Atmospheric or power type with electric ignition and gas pressure regulator.

.2 Collector and Draft Hood: Provide atmospheric gas-fired boiler with natural draft operation and equipment as regularly supplied by boiler manufacturer.

3. EXECUTION

3.1 Installation

.1 Install boilers on a 100 mm concrete housekeeping pad and level, as required.

.2 Install with adequate clearance as required by code and manufacturer.

.3 Provide the services of a factory trained representative to supervise testing and start-up of boiler and ancillaries.

.4 Start up procedures shall include boil out with phosphate free chemical as directed by the manufacturer.

END OF SECTION

Unit Number	CH-1	CH-2	
Location	Roof	Ground	
Manufacturer			
Model			
Type			
Capacity (tons)			
Chilled Water:			
Flow (l/s)			
P.D. (kPa)			
EWT (□C)			
LWT (□C)			
Condensor Water:			
Flow (l/s)			
P.D. (kPa)			
EWT (□C)			
LWT (□C)			
Compressor Input (kW)			
MCA at Motor kW (amps)			
Volts/Phase/Hz			
Unit EER			
Fouling Factor			

Notes:

1. Chiller complete with the following:
   - disconnect switch, circuit breakers and starter
   - low ambient air controller
   - hot gas bypass
   - gauges, cycle counter and hour meter
   - control transformer
   - chilled water temperature rest
   - DDC terminal strip with the following points:
     - start/stop
     - chiller status
     - chilled water temperature reset
     - alarms
   - insulation
   - start-up and operator instruction
   - control panel
   - sound attenuation package
2. Remote condenser barrel

END OF SCHEDULE

Unit Number	B-1	B-2	B-3
Location	Penthouse	Penthouse	Penthouse
Manufacturer	Camus	Camus	Camus
Model Number	MFNH 4000	MFNH 4000	MFNH 4000
Input (kW)	1172	1172	1172
Output (kW)	936	936	936
Operating Temp (°C)	99	99	99

Unit Number	B-4		
Location	Penthouse		
Manufacturer	Camus		
Model Number	MFNH 4000		
Input (kW)	1172		
Output (kW)	936		
Operating Temp (°C)	99		

Notes:
1. Output at elevation
2. Intermittent ignition
3. Three stage firing
4. Low water cut-off.
5. Temperature and pressure gauge.
6. Relief valves.
7. CSA approved.
8. Gas valve.
9. DDC terminal strip with:
   - start/stop (each boiler)
   - status
   - supply water reset
10. Flow switch
11. Provide HOA switch for each boiler module
12. Control transformer

END OF SCHEDULE

Unit Number	CH-1	CH-2	CH-3
Location	Ground	Roof	Roof
Manufacturer			
Model			
Type			
Capacity (tons)			
Chilled Water:			
Flow (l/s)			
P.D. (kPa)			
EWT (□C)			
LWT (□C)			
Condensor Water:			
Flow (l/s)			
P.D. (kPa)			
EWT (□C)			
LWT (□C)			
Compressor Input (kW)			
MCA at Motor kW (amps)			
Volts/Phase/Hz			
Unit EER			
Fouling Factor			

Notes:

1. Chiller complete with the following:
   - disconnect switch, circuit breakers and starter
   - low ambient air controller
   - hot gas bypass
   - gauges, cycle counter and hour meter
   - control transformer
   - chilled water temperature rest
   - DDC terminal strip with the following points:
     - start/stop
     - chiller status
     - chilled water temperature reset
     - alarms
   - insulation
   - start-up and operator instruction
   - control panel
   - sound attenuation package
2. Remote condenser barrel

END OF SCHEDULE

Unit Number	HWH-1	HWH-2	HWH-3
Service	Lower zone	Lower zone	Lower zone
Location	Main floor mech room	Main floor mech room	Main floor mech room
Storage Capacity (l)	378	378	378
Input (kW)	117	117	117
Recovery Capacity (LPH)	1465	1465	1465
Temperature Rise (C)	56	56	56
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	AO Smith	AO Smith	AO Smith
Model Number	BTRC 400A	BTRC 400A	BTRC 400A
Notes	1, 2, 3	1, 2, 3	1, 2, 3

Unit Number	HWH-4	HWH-5	HWH-6
Service	Mid-lower zone	Mid-lower zone	Mid-lower zone
Location	Main floor mech room	Main floor mech room	Main floor mech room
Storage Capacity (Gal)	378	378	378
Input (kW)	117	117	117
Recovery Capacity (LPH)	1465	1465	1465
Temperature Rise (C)	56	56	56
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	AO Smith	AO Smith	AO Smith
Model Number	BTRC 400A	BTRC 400A	BTRC 400A
Notes	1, 2, 3	1, 2, 3	1, 2, 3

Unit Number	HWH-7	HWH-8	HWH-9
Service	Mid-upper zone	Mid-upper zone	Mid-upper zone
Location	Penthouse	Penthouse	Penthouse
Storage Capacity (l)	378	378	378
Input (kW)	58	58	58
Recovery Capacity (LPH)	729	729	729
Temperature Rise (C)	56	56	56
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	AO Smith	AO Smith	AO Smith
Model Number	BTRC 197	BTRC 197	BTRC 197
Notes	2, 3	2, 3	2, 3

Unit Number	HWH-10	HWH-11	HWH-12
Service	Upper zone	Upper zone	Upper zone
Location	Penthouse	Penthouse	Penthouse
Storage Capacity (l)	378	378	378
Input (kW)	58	58	58
Recovery Capacity (LPH)	729	729	729
Temperature Rise (C)	56	56	56
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	AO Smith	AO Smith	AO Smith
Model Number	BTRC 197	BTRC 197	BTRC 197
Notes	2, 3	2, 3	2, 3

Notes:
1. Side wall venting kit
2. Flue Damper
3. Intermittent ignition

END OF SCHEDULE

Unit Number	EF-1	EF-2	EF-3
Fan Type	Square Centrifugal	Square Centrifugal	Square Centrifugal
Service	Exhaust Fan	Exhaust Fan	Exhaust Fan
Location	P4 North Mech	P3 North Mech	P2 North Mech
Air Flow (l/s)	11,750	11,750	11,750
E.S.P. (Pa)	124	124	124
Fan (RPM)	678	678	678
Drive Type	Belt	Belt	Belt
Motor Power (HP)	7 1/2	7 1/2	7 1/2
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Manufacturer	Cook	Cook	Cook
Model No.	402SQI-B	402SQI-B	402SQI-B
Notes	1, 14	1, 14	1, 14

Unit Number	EF-4	EF-5	EF-6
Fan Type	Square Centrifugal		
Service	Exhaust Fan	Residential Garbage	Commercial Garbage
Location	P1 North Mech	Residential Garbage	Commercial Garbage
Air Flow (l/s)	11,750		
E.S.P. (Pa)	124		
Fan (RPM)	678		
Drive Type	Belt		
Motor Power (HP)	7 1/2		
Volts/Phase/Hz	208/3/60		
Manufacturer	Cook		
Model No.	402SQI-B		
Notes	1, 14		

Unit Number	EF-7	EF-8	EF-9
Fan Type			Centrifugal Inline
Service	Main floor washroom	Second floor washroom	Parkade jan rooms
Location	Main floor washroom	Second floor washroom	Main Floor Janitor
Air Flow (l/s)			235
E.S.P. (Pa)			124
Fan (RPM)			1100
Drive Type			
Motor Power (HP)			Frac.
Volts/Phase/Hz			120/1/60
Manufacturer			Greenheck
Model No.			CSP-A700
Notes			1

Unit Number	EF-10	EF-11	
Fan Type	Centrifugal Inline	Centrifugal Inline	
Service	Enmax Vault	Refrigerant Exhaust	
Location	Enmax Vault	Main Floor Mechanical	
Air Flow (l/s)	4042	566	
E.S.P. (Pa)	100	125	
Fan (RPM)	566	1750	
Drive Type	Belt	Belt	
Motor Power (HP)	1 ½	½	
Volts/Phase/Hz	208/3/60	115/1/60	
Manufacturer	Greenheck	Greenheck	
Model No.	BSQ-300	BSQ-100	
Notes	1, 14	1, 14	

Unit Number	TF-1	TF-2	TF-3
Fan Type	Centrifugal Inline	Centrifugal Inline	Ceiling Exhaust
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P4 South Mech	P4 North Mech	P4 North East Storage
Air Flow (l/s)	512	115	22
E.S.P. (Pa)	92	92	92
Fan (RPM)	1564	1050	675
Drive Type	Belt	Belt	Direct
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	BSQ-100-4	CSP-A290	SP-B70
Notes			

Unit Number	TF-4	TF-5	TF-6
Fan Type	Ceiling Exhaust	Ceiling Exhaust	Centrifugal Inline
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P4 East Storage	P4 South Storage	P3 South Mech
Air Flow (l/s)	22	22	418
E.S.P. (Pa)	92	92	92
Fan (RPM)	675	675	1764
Drive Type	Direct	Direct	Belt
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	SP-B70	SP-B70	BSQ-90-4
Notes			

Unit Number	TF-7	TF-8	TF-9
Fan Type	Ceiling Exhaust	Centrifugal Inline	Ceiling Exhaust
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P3 West Storage	P3 North Mech	P3 North East Storage
Air Flow (l/s)	71	115	22
E.S.P. (Pa)	92	92	92
Fan (RPM)	1050	1050	675
Drive Type	Direct	Belt	Direct
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	SP-B150	CSP-A290	SP-B70
Notes			

Unit Number	TF-10	TF-11	TF-12
Fan Type	Ceiling Exhaust	Ceiling Exhaust	Centrifugal Inline
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P3 East Storage	P3 South Storage	P2 South Mech
Air Flow (l/s)	22	22	418
E.S.P. (Pa)	92	92	92
Fan (RPM)	675	675	1764
Drive Type	Direct	Direct	Belt
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	SP-B70	SP-B70	BSQ-90-4
Notes			

Unit Number	TF-13	TF-14	TF-15
Fan Type	Ceiling Exhaust	Ceiling Exhaust	Centrifugal Inline
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P2 West Storage	P2 North West Storage	P2 North Mech
Air Flow (l/s)	71	22	115
E.S.P. (Pa)	92	92	92
Fan (RPM)	1050	675	1050
Drive Type	Direct	Direct	Belt
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	SP-B150	SP-B70	CSP-A290
Notes			

Unit Number	TF-16	TF-17	TF-18
Fan Type	Ceiling Exhaust	Ceiling Exhaust	Centrifugal Inline
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P2 North East Storage	P2 East Storage	P2 South East Storage
Air Flow (l/s)	22	22	45
E.S.P. (Pa)	92	92	92
Fan (RPM)	675	675	950
Drive Type	Direct	Direct	Direct
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	SP-B70	SP-B70	BSQ-B110
Notes			

Unit Number	TF-19	TF-20	TF-21
Fan Type	Centrifugal Inline	Ceiling Exhaust	Centrifugal Inline
Service	Transfer Fan	Transfer Fan	Transfer Fan
Location	P1 South Mech	P1 West Storage	P1 North Mech
Air Flow (l/s)	418	71	115
E.S.P. (Pa)	92	92	92
Fan (RPM)	1764	1050	1050
Drive Type	Belt	Direct	Belt
Motor Power (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Greenheck	Greenheck	Greenheck
Model No.	BSQ-90-4	SP-B150	CSP-A290
Notes			

Unit Number	TF-22	TF-23	
Fan Type	Ceiling Exhaust	Ceiling Exhaust	
Service	Transfer Fan	Transfer Fan	
Location	P1 North East Storage	P1 East Storage	
Air Flow (l/s)	22	22	
E.S.P. (Pa)	92	92	
Fan (RPM)	675	675	
Drive Type	Direct	Direct	
Motor Power (HP)	Frac.	Frac.	
Volts/Phase/Hz	120/1/60	120/1/60	
Manufacturer	Greenheck	Greenheck	
Model No.	SP-B70	SP-B70	
Notes			

Unit Number			
Fan Type			
Service			
Location			
Air Flow (l/s)			
E.S.P. (Pa)			
Fan (RPM)			
Drive Type			
Motor Power (HP)			
Volts/Phase/Hz			
Manufacturer			
Model No.			
Notes			

Unit Number			
Fan Type			
Service			
Location			
Air Flow (l/s)			
E.S.P. (Pa)			
Fan (RPM)			
Drive Type			
Motor Power (HP)			
Volts/Phase/Hz			
Manufacturer			
Model No.			
Notes			

Unit Number			
Fan Type			
Service			
Location			
Air Flow (l/s)			
E.S.P. (Pa)			
Fan (RPM)			
Drive Type			
Motor Power (HP)			
Volts/Phase/Hz			
Manufacturer			
Model No.			
Notes			

NOTES:
1. Backdraft damper.
2. Acoustic lined cabinet.
3. Explosion proof motor.
4. Aluminum construction.
5. Epoxy coated wheel.
6. Epoxy coated wheel and B.D.D.
7. NFPA-96 food service installation.
8. Polypropylene construction.
9. 12 mm insulated cabinet.
10. Stainless steel shaft.
11. Disconnect switch.
12. Spark proof wheel.
13. Vertical mounting.
14. High efficiency motor.
15. Integral grille.

END OF SCHEDULE

Unit Number	UH-1	UH-2	UH-3
Location	Parkade Entrance	Parkade Entrance	Gas Meter Room
Capacity (kW)	32.7	23.2	16.7
Airflow (l/s)	831	689	472
Liquid:			
Flow (l/s)	0.70	0.70	0.70
EWT (°C)	82	82	82
LWT (°C)	71	71	71
Motor (HP)	Frac.	Frac.	Frac.
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Manufacturer	Engineered Air	Engineered Air	Engineered Air
Model Number	H-7	H-6	H-4
Notes			

Unit Number	UH-4		
Location	Water Meter Room		
Capacity (kW)	8.6		
Airflow (l/s)	260		
Liquid:			
Flow (l/s)	0.70		
EWT (°C)	82		
LWT (°C)	71		
Motor (HP)	Frac.		
Volts/Phase/Hz	120/1/60		
Manufacturer	Engineered Air		
Model Number	H-1		
Notes			

Unit Number			
Location			
Capacity (kW)			
Airflow (l/s)			
Liquid:			
Flow (l/s)			
EWT (°C)			
LWT (°C)			
Motor (HP)			
Volts/Phase/Hz			
Manufacturer			
Model Number			
Notes			

Notes:

END OF SCHEDULE

Unit Number	MUA-1	MUA-2	MUA-3
Service	P1 Parkade	P2 Parkade	P3 Parkade
Location	P1 Parkade	P2 Parkade	P3 Parkade
Manufacturer	Engineered Air	Engineered Air	Engineered Air
Model	HE-250	HE-250	HE-250
Blower Section: Discharge	Up	Up	Up
Intake	Horizontal	Horizontal	Horizontal
Air flow (l/s)	11,750	11,750	11,750
E.S.P. (Pa)	125	125	125
Motor (HP)	20	20	20
Burner Section:			
Input (kW)	802	802	802
Output (kW)	802	802	802
Temp. Rise (^{O}C)	56	56	56
Cooling Coil: Coil Type	N/A	N/A	N/A
Rows			
Sensible Cooling (kW)			
Total Cooling (kW)			
EAT (°C) (DB/WB)			
LAT (°C) (DB/WB)	2600 lbs		
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Notes	All	All	All

Unit Number	MUA-4	MUA-5	MUA-6
Service	P4 Parkade	Stair Pressurisation	Lower Level Make-up
Location	P4 Parkade	P1 Parkade	Main floor mech room
Manufacturer	Engineered Air	Engineered Air	Engineered Air
Model	HE-250	HE-100	DJ-100C
Blower Section: Discharge	Up		
Intake	Horizontal		
Air flow (l/s)	11,750	4,250	2,400
E.S.P. (Pa)	125	125	125
Motor (HP)	20	7 1/2	5
Burner Section:			
Input (kW)	802	290	191
Output (kW)	802	290	156
Temp. Rise (^{O}C)	56	56	56
Cooling Coil: Coil Type	N/A	N/A	Water
Rows			2
Sensible Cooling (kW)			29.75
Total Cooling (kW)			29.75
EAT (°C) (DB/WB)			29/17
LAT (°C) (DB/WB)		1300 lbs	63/56 5000 lbs
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Notes	All	All	All

Unit Number	MUA-7	MUA-8	
Service	Upper Level Make-up	Podium Make-up	
Location	Penthouse	Main floor mech room	
Manufacturer	Engineered Air	Engineered Air	
Model	DJ-100C	DJ-60C	
Blower Section: Discharge			
Intake			
Air flow (l/s)	2,400	1,880	
E.S.P. (Pa)	125	125	
Motor (HP)	5	3	
Burner Section:			
Input (kW)	191	147	
Output (kW)	156	119	
Temp. Rise (^{O}C)	56	56	
Cooling Coil: Coil Type	Water	Water	
Rows	2	2	
Sensible Cooling (kW)	29.75	22.63	
Total Cooling (kW)	29.75	22.63	
EAT (°C) (DB/WB)	29/17	29/17	
LAT (°C) (DB/WB)	63/56 5000 lbs	63/56 3500 lbs	
Volts/Phase/Hz	208/3/60	208/3/60	
Notes	All	All	

Notes:
1. High efficiency motor.
2. Intake louvre, hood and low leakage outside air damper.
3. 25 mm internal insulation.
4. Internal fan isolation spring isolator.
5. Control transformer and all internal controls.
6. Heavy duty side hinged access doors.
7. One year warranty for heat exchanger.
8. Fully modulating gas valve with built-in supply air control and proportional combustion air.
9. DDC terminal strip

END OF SCHEDULE

Unit Number	P-1	P-2	P-3
Pump Type	Close Coupled Inline	Close Coupled Inline	Close Coupled Inline
Service	Main Heating	Main Heating	Lower Radiation
Location	Penthouse	Penthouse	Main floor mech room
Capacity (l/s)	25	25	20.5
Diff. Pressure (kPa)	225	225	150
Pump (RPM)	1800	1800	1800
Motor Power (HP)	15	15	7 ½
Manufacturer	Armstrong	Armstrong	Armstrong
Model Number	6 x 6 x 10	6 x 6 x 10	4 x 4 x 8
Series	4380	4380	4380
Individual flow (l/s)	42.3	42.3	35.0
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Notes	1, 3	1, 3	1, 3

Unit Number	P-4	P-5	P-6
Pump Type	Close Coupled Inline	Close Coupled Inline	Close Coupled Inline
Service	Lower Radiation	Upper Chiller	Upper Chiller
Location	Main floor mech room	Penthouse	Penthouse
Capacity (l/s)	20.5	19	19
Diff. Pressure (kPa)	150	150	150
Pump (RPM)	1800	1800	1800
Motor Power (HP)	7 ½	7 ½	7 ½
Manufacturer	Armstrong	Armstrong	Armstrong
Model Number	4 x 4 x 8	4 x 4 x 8	4 x 4 x 8
Series	4380	4380	4380
Individual flow (l/s)	35.0	33.1	33.1
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Notes	1, 3	1, 3	1, 3

PUMPS (continued)

Unit Number	P-7	P-8	P-9
Pump Type	Close Coupled Inline	Close Coupled Inline	Submersible
Service	Lower Chiller	Lower Chiller	Sanitary Sump
Location	Main floor mech room	Main floor mech room	P4 Parkade
Capacity (l/s)	19	19	3.2
Diff. Pressure (kPa)	150	150	180
Pump (RPM)	1800	1800	3450
Motor Power (HP)	7 ½	7 ½	2
Manufacturer	Armstrong	Armstrong	Hydromatic
Model Number	4 x 4 x 8	4 x 4 x 8	SKHS200
Series	4380	4380	-
Individual flow (l/s)	33.1	33.1	-
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Notes	1, 3	1, 3	2, 3

Unit Number	P-10	P-11	P-12
Pump Type	Submersible	Submersible	Submersible
Service	Sanitary Sump	Weeping Sump	Weeping Sump
Location	P4 Parkade	P4 Parkade	P4 Parkade
Capacity (l/s)	3.2	3.2	3.2
Diff. Pressure (kPa)	180	224	224
Pump (RPM)	3450	3450	3450
Motor Power (HP)	2	1	1
Manufacturer	Hydromatic	Monarch	Monarch
Model Number	SKHS200	WS100H	WS100H
Series	-	-	-
Individual flow (l/s)	-	-	-
Volts/Phase/Hz	208/3/60	208/3/60	208/3/60
Notes	2, 3	2, 3	2, 3

PUMPS (continued)

Unit Number	P-13	P-14	P-15
Pump Type	Submersible	Circulator	Circulator
Service	Elevator Sump	Low Zone Recirc	Mid-Low Zone Recirc
Location	P4 Parkade	Main floor mech room	Main floor mech room
Capacity (l/s)	0.63	0.65	0.65
Diff. Pressure (kPa)	84	75	75
Pump (RPM)	1550	3600	3600
Motor Power (HP)	4/10	Frac.	Frac.
Manufacturer	Hydromatic	Armstrong	Armstrong
Model Number	SHEF40	E8B	E8B
Series	-	E	E
Individual flow (l/s)	-	N/A	N/A
Volts/Phase/Hz	120/1/60	120/1/60	120/1/60
Notes		3, 4	3, 4

Unit Number	P-16	P-17	P-18
Pump Type	Circulator	Circulator	Close Coupled Inline
Service	Mid-Upper Zone Recirc	Upper Zone Recirc	Upper Radiation
Location	Penthouse	Penthouse	Penthouse
Capacity (gpm)	0.65	0.65	15.75
Diff. Pressure (kPa)	75	75	150
Pump (RPM)	3600	3600	1800
Motor Power (HP)	Frac.	Frac.	5
Manufacturer	Armstrong	Armstrong	Armstrong
Model Number	E8B	E8B	3 x 3 x 8
Series	E	E	4380
Individual flow (l/s)	N/A	N/A	23.9
Volts/Phase/Hz	120/1/60	120/1/60	208/3/60
Notes	3, 4	3, 4	1, 3

Unit Number	P-19	P-20	P-21
Pump Type	Close Coupled Inline		
Service	Upper Radiation		
Location	Penthouse		
Capacity (gpm)	15.75		
Diff. Pressure (kPa)	150		
Pump (RPM)	1800		
Motor Power (HP)	5		
Manufacturer	Armstrong		
Model Number	3 x 3 x 8		
Series	4380		
Individual flow (l/s)	23.9		
Volts/Phase/Hz	208/3/60		
Notes	1, 3		

Unit Number			
Pump Type			
Service			
Location			
Capacity (l/s)			
Diff. Pressure (kPa)			
Pump (RPM)			
Motor Power (HP)			
Manufacturer			
Model Number			
Series			
Individual flow (l/s)			
Volts/Phase/Hz			
Notes			

Notes:
1. Parallel operation.
2. Each at 100% capacity with one as standby.
3. High efficiency motor
4. All bronze construction.

END OF SCHEDULE

1. GENERAL

1.1 Documents

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

1.2 Scope

.1 Extra high efficiency motors.

1.3 Quality Assurance

.1 I.E.E.E. 112 classification tests.

.2 All motors shall be constructed in accordance with latest, CEMA, NEMA, ANSI and NEC standards.

.3 Motor speeds shall be either 1200 rpm or 1800 rpm unless otherwise specified.

.4 Motors shall be designed for continuous duty operation, NEMA 'B' design. Limit temperature rise to 55□C, T.E.F.C. or O.D.P. Do not utilize air over ratings.

.5 Refer to Section 15010, General Conditions.

.6 Provide label on motor to indicate efficiency.

1.4 Submittals

.1 Submit motor manufacturer shop drawing information indicating classification and efficiency characteristics and range.

.2 Submit motor lists and back-up data to Consultant for Power Smart Application.

2. PRODUCTS

2.1 General Requirements

.1 All motors shall be provided with extra high efficiency classification with non-wicking leads, class 'B' for O.D.P. motors (pumps only) and class 'F' for TEFC motors insulation (minimum).

.2 All motors shall have ball or roller bearings.

.3 Provide adjustable motor frame base for belt driven equipment.

.4 Provide disconnect switch and interconnect wiring and conduit to motor.

.5 Motors 20 H.P. and over shall have capacitors for P.F. correction.

.6 All motors 7.5 HP and over shall have 6 leads suitable for across the line starters and wye delta starters.

2.2 Sound

.1 Maximum sound pressure level measured in from motor to be less than 85 dBa.

2.3 Enclosure

.1 Enclosures shall be manufactured to ASTM Type A-48 or better (cast iron).

2.4 Manufacturers

.1 Acceptable motors are: Century Electric "E plus iii", Teco MAX-E1, Baldour "Super E" or equal and approved.

2.5 Efficiencies

.1 Extra high efficiency open motors shall have the following typical efficiencies (minimum):

HP	1200 RPM	1800 RPM	3600 RPM
1	80	82.5	75.5
1.5	84.0	84	82.5
2	85.5	84	84
3	86.5	86.5	84
5	87.5	87.5	85.5
7.5	88.5	88.5	87.5
10	90.2	89.5	88.5
15	90.2	91	89.5
20	91.0	91	90.2
25	91.7	91.7	91
30	92.4	92.4	91
40	93.0	93.0	91.7
50	93.0	93.0	92.4
60	93.6	93.6	93.0
75	93.6	94.1	93.0
100	94.1	94.1	93.0
125	94.1	94.5	93.6
150	94.5	95.0	93.6
200	94.5	95.0	94.5

.2 Extra high efficiency closed motors shall have the following typical efficiencies (minimum).

HP	1200 RPM	1800 RPM	3600 RPM
1	80	82.5	75.2
1.5	85.5	84	82.5
2	86.5	84	84
3	87.5	87.5	85.5
5	87.5	87.5	87.5
7.5	89.5	89.5	88.5
10	89.5	89.5	89.5
15	90.2	91	90.2
20	90.2	91	90.2
25	91.7	92.4	91.0
30	91.7	92.4	91.0
40	93.0	93.0	91.7
50	93.0	93.0	92.4
60	93.6	93.6	93.0
75	93.6	94.1	93.0
100	94.1	94.5	93.6
125	94.1	94.5	94.5
150	95.0	95.0	94.5
200	95.0	95.0	95.0

3. EXECUTION

.1 Provide extra high efficiency motors to all HVAC equipment on this project, including fans, pumps, compressors, air handling units, etc.).

.2 Refer individual equipment schedules for sizes and voltages of motors.

.3 Provide compatible keyed shaft to match rotating equipment being driven. Provide space coupling at shaft drive as required.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Air cooled chiller package.

.2 Charge of refrigerant and oil.

.3 Controls and control panel.

.4 Chilled water connections.

.5 Refrigerant connections.

.6 Starters.

.7 Electrical power connection.

.8 Start-up service.

1.2 Quality Assurance

.1 Provide microprocessor controlled, air-cooled liquid chiller utilizing scroll compressors, low sound fans, outdoor package type, pre-wired, factory assembled and products of a manufacturer regularly engaged in production of units of type and size specified and who issues complete catalogue data on such products.

.2 Manufacturer shall be responsible for selection and operation of components furnished by him. Provide written certification that components not furnished by him have been selected in accordance with his requirements.

.3 Chillers shall be rated in accordance with ARI Standards and shall have UL or CSA approvals.

.4 Unit construction shall comply with ASHRAE 15 Safety Code, UL 1995, and ASME applicable codes (U.S.A. codes).

.5 Unit shall be manufactured in a facility registered to ISO 9001:2000 Manufacturing Quality Standard.

.6 Unit shall be full load run tested at the factory.

1.3 Shop Drawings

.1 Show on shop drawings equipment, piping connections, valves, strainers, and thermostatic valves required for complete system.

1.4 Start-Up

.1 Supply initial charge of refrigerant and oil.

.2 Supply service of factory trained representative to supervise testing, dehydration and charging of unit, start-up and instruction on operation and maintenance to Owner.

.3 Provide start-up service with report.

2. PRODUCTS

2.1 General

.1 Factory assembled, single-piece or factory-matched duplex chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (R-410A), and special features required prior to field start-up.

2.2 Unit Cabinet:

.1 Frame shall be of heavy-gage, painted galvanized steel.

.2 Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.

.3 Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (U.S.A.) B-117 standard.

2.3 Fans

.1 Condenser fans shall be direct-driven, 9-blade airfoil cross-section, reinforced polymer construction, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.

.2 Air shall be discharged vertically upward.

.3 Fans shall be protected by coated steel wire safety guards.

2.4 Compressor/Compressor Assembly

.1 Fully hermetic scroll type compressors.

.2 Direct drive, 3500 rpm (60 Hz), protected by motor temperature sensors, suction gas cooled motor.

.3 External vibration isolation rubber-in-shear.

.4 Each compressor shall be equipped with crankcase heaters to minimize oil dilution.

2.5 Cooler

.1 Shell-and-tube type, direct expansion.

.2 Tubes shall be internally enhanced seamless-copper type rolled into tube sheets.

.3 Shall be equipped with Victaulic-type fluid connections.

.4 Shell shall be insulated with $^3/_4$-in. (19-mm) PVC foam (closed-cell) with a maximum K factor of 0.28.

.5 Design shall incorporate a minimum of 2 independent direct-expansion refrigerant circuits.

.6 Cooler shall be tested and stamped in accordance with ASME Code for a refrigerant working side pressure of 445 psig (3068 kPa). Cooler shall have a maximum fluid-side pressure of 300 psig (2068 kPa).

2.6 Condenser

.1 Coil shall be air-cooled with integral subcooler, and shall be constructed of aluminum fins mechanically bonded to seamless copper tubes.

.2 Tubes shall be cleaned, dehydrated, and sealed.

.3 Assembled condenser coils shall be leak tested and pressure tested at 656 psig (4522 kPa).

2.7 Refrigeration Components

.1 Refrigerant circuit components shall include replaceable-core filter drier, moisture indicating sight glass, electronic expansion device, discharge service valve and liquid line service valves, and complete operating charge of both refrigerant R-410A and compressor oil.

2.8 Controls, Safeties, and Diagnostics

.1 Unit controls shall include the following minimum components:
- .1 Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
- .2 Separate terminal block for power and controls.
- .3 Control transformer to serve all controllers, relays, and control components.
- .4 ON/OFF control switch.
- .5 Replaceable solid-state controllers.
- .6 Pressure sensors installed to measure suction and discharge pressure. Thermistors installed to measure cooler entering and leaving fluid temperatures.

.2 Unit controls shall include the following functions.
- .1 Automatic circuit lead/lag.
- .2 Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1° F (0.06° C).
- .3 Limiting the chilled fluid temperature pull-down rate at start-up to an adjustable range of 0.2° F to 2° F (0.11° C to 1.1° C) per minute to prevent excessive demand spikes at start-up.
- .4 Seven-day time schedule.
- .5 Leaving chilled fluid temperature reset from return fluid.
- .6 Chilled water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
- .7 Dual chiller control for parallel chiller applications without addition of hardware modules, control panels.
- .8 Timed maintenance scheduling to signal maintenance activities for pumps, strainer maintenance and user-defined maintenance activities.

.9 Low ambient protection to energize cooler and hydronic system heaters.
.10 Periodic pump start to ensure pump seals are properly maintained during off-season periods.

.3 Diagnostics:
.1 The control panel shall include, as standard, a Scrolling Marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
.2 Information included for display shall be:
.1 Compressor lockout.
.2 Loss of charge.
.3 Low fluid flow.
.4 Cooler freeze protection.
.5 Thermistor or transducer malfunction.
.6 Entering and leaving-fluid temperature.
.7 Evaporator and condenser pressure.
.8 Time of day:
.1 Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
.2 Diagnostics shall include the ability to review a list of the 30 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
.3 An alarm history buffer shall allow the user to store no less than 30 alarm events with clear language descriptions, time and date stamp event entry.
.4 The chiller controller shall include multiple connection ports for communicating with the local equipment network, the Carrier Comfort Network (CCN) and the ability to access all chiller control functions from any point on the chiller.
.5 The control system shall allow software upgrade without the need for new hardware modules.
.9 Crankcase heater failure.

.4 Safeties:
.1 Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
.1 Loss of refrigerant charge.
.2 Reverse rotation.
.3 Low chilled fluid temperature.
.4 Thermal overload.
.5 High pressure.
.6 Electrical overload.
.7 Loss of phase.
.2 Condenser fan and factory pump motors shall have external overcurrent protection.

2.9 Operating Characteristics

.1 Unit shall be capable of starting and running at outdoor ambient temperatures from 32 F to 125 F (0° to 52 C) for all sizes.

.2 Unit shall be capable of starting up with 95 F (35 C) entering fluid temperature to the cooler.

2.10 Motors

.1 Condenser-fan motors shall be totally enclosed single speed, 3-phase type with permanently lubricated bearings and Class F insulation.

2.11 Electrical Requirements

.1 Unit/module primary electrical power supply shall enter the unit at a single location (some chiller voltage/size combinations require 2 power supplies).

.2 Primary electrical power supply shall be rated to operate up to 125 F (52 C) ambient temperature.

.3 Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.

.4 Control points shall be accessed through terminal block.

.5 Unit shall be shipped with factory control and power wiring installed.

2.12 Chilled Water Circuit

.1 Chilled water circuit shall be rated for 300 psig (2068 kPa). Units with optional pump package are rated for 150 psig (1034 kPa) working pressure.

.2 Proof of flow switch shall be factory installed and wired.

2.13 Special Features

.1 Head Pressure Control
- .1 Unit shall be capable of starting and running at outdoor ambient temperatures down to –20 F (–29 C) with the addition of antifreeze in the cooler circuit, wind baffles, and field- installed or factory-installed solid-state Motormaster control with condenser coil temperature sensor.

.2 Unit-Mounted Non-Fused Disconnect
- .1 Unit shall be supplied with factory-installed, non-fused electrical disconnect for main power supply.

.3 Condenser Coil Materials
- .1 Pre-coated aluminum fin coils:
  - .1 Shall have a durable epoxy-phenolic coating to provide protection in mildly corrosive coastal environments. Coating shall be applied to the aluminum fin stock prior to the fin stamping process to create an inert barrier between the aluminum fin and copper tube. Epoxy-phenolic barrier shall minimize galvanic action between dissimilar metals.

.4 Remote Enhanced Display
- .1 Unit shall be supplied with indoor-mounted, remote, 40-character per line, 16-line display panel for field installation.

.5 Chillervisor System Manager Multi-Unit Control

.1 Field-installed control shall sequence between 2 and 8 chillers in parallel in a single system. System shall control chilled water pumps.

.6 Minimum Load Control

.1 Unit shall be equipped with factory (or field) installed, microprocessor-controlled, minimum-load control that shall permit unit operation down to a minimum of 15% capacity (varies with unit size).

.7 Energy Management Control Module

.1 A factory or field-installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point reset or demand limit control; 2-step demand limit control (from 15% to 100%) activated by a remote contact closure; and discrete input for "Ice Done" indication for ice storage system interface.

.8 Coil Covers and Security Grilles

.1 Unit shall be supplied with field-installed coil covers and PVC-coated grilles to protect the condenser coil and internal chiller components from physical damage.

.9 Compressor Suction Service Valve

.1 Standard refrigerant discharge isolation and liquid valves enable service personnel to store the refrigerant charge in the cooler or condenser during servicing. This factory-installed option allows for further isolation of the compressor from the cooler vessel.

.10 Remote Cooler Kit

.1 Allows remote installation of cooler. Kit includes thermistor and transducer cable extension, sheet metal panels for refrigerant pipe extensions and instructions.

3. EXECUTION

3.1 Installation

.1 Install chiller package on steel or concrete beams in accordance with manufacturers' recommendations.

3.2 Performance

.1 Refer to Schedule.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Manual and automatic air vents.

.2 Air separators.

.3 Air scoops.

.4 Relief valves.

.5 Combination valves and fittings.

.6 Radiation valves.

1.2 Quality Assurance

.1 Comply with Provincial Regulations and have CSA approval.

1.3 Submittals

.1 Provide shop drawings and schedules for review where requested.

2. PRODUCTS

2.1 Manual Air Vents

.1 Construct manual air vents from short vertical section of 50mm (2") diameter pipe to form air chamber. Provide 6mm (¼") brass ball valve at top of chamber.

2.2 Automatic Air Vents

.1 Provide automatic float type with isolating ball valve, brass or semi steel body, copper float, stainless steel valve and valve seat, suitable for system operating temperature and pressure.

2.3 Air Separators

.1 Provide centrifugal, type with 860 kPa (125 psi) WSP steel tank, galvanized steel 5mm (¼") perforated strainer, perforated stainless steel air collector tube and drain connection.

2.4 Relief Valve

.1 Provide ASME rated direct spring loaded type, lever operated non-adjustable factory set discharge pressure as indicated.

2.5 Handwheel Radiator Valve

.1 Provide angle or straight, rising stem, global valve, with bronze body and renewable composition disc.

2.6 Radiator Balancing Valve

.1 Provide angle or straight, rising stem, combination, balancing, indicating and shut off valve.

.2 Construct body, bonnet, stem and packing nut of bronze or brass.

.3 Provide stainless steel indicating dial plate and lockable balancing yoke.

3. EXECUTION

3.1 Air Vents

.1 Provide manual type at system high points.

.2 Use automatic float type at heating units, system high points in boiler rooms and at areas not readily accessible for servicing.

.3 Use automatic washer type for convection type heating units.

.4 Where large air quantities can accumulate, provide enlarged air collection standpipes.

.5 For float type air vents provide 6mm (¼") copper vent tubing from each vent and pipe to nearest floor drain.

.6 Provide identification for all vent drains at outlet.

3.2 Air Separator

.1 Provide on suction side of the system circulation pump.

3.3 Relief Valves

.1 Provide relief valves on pressure tanks, low pressure side of reducing valves, heating convectors, expansion tanks, boiler, DHW heaters, and where indicated.

.2 Drain relief valve to nearest floor drain.

.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 area shall equal sum of individual vent areas.

3.4 Handwheel Radiator Valves

.1 Provide on water inlet to terminal heating units such as radiation.

3.5 Radiator Balancing Valve

.1 Provide on water outlet from terminal heating units such as radiation.

END OF SECTION

1. GENERAL

.1 Heat exchanger shall be product of manufacturer regularly engaged in production of units of type and size specified, who issues complete catalogue data, operating and maintenance instructions on such products.

.2 Unit shall be factory assembled. For shipping, unit may be disassembled into as large as practical sub-assemblies. Minimum amount of field work shall be required for reassembly.

.3 Submit suggested structural support drawings including dimensions, sizes and locations for mounting bolt holes.

.4 Manufacturers representative shall inspect the heat exchanger after installation is complete and submit a report to start-up, verifying installation is in accordance with specifications and maintenance recommendations.

.5 All domestic water heat exchangers shall be double wall type with atmosphere relief upon failure.

2. PRODUCTS

2.1 Heat Exchanger

.1 Furnish and install as shown on the plans and specifications a plate and frame heat exchanger. The unit shall be suitable for a cleaning-in-place system and shall be able to be completely disassembled for manual cleaning of each plate.

2.2 Plates

.1 The heat transfer plates shall be fabricated of Type 304 stainless steel. Gaskets shall be nitrile rubber.

2.3 Frame

.1 The frame shall be constructed of carbon steel with baked epoxy enamel finish. The guide bars shall be hard chrome plated carbon steel with zinc treated carbon steel paint protected shroud. Four (4) anchor bolts shall be provided.

2.4 Nozzles

.1 The nozzles shall be constructed of 316L stainless steel. All nozzles shall be 1034 kPa (150 lb.). ASA rated loose flange type.

3. EXECUTION

3.1 Capacities

.1 Refer to equipment schedule for capacities, flows, temperature changes and pressure drops.

3.2 Installation

.1 Make all final connections to heat exchanger.

.2 Provide thermometers and pressure gauge tappings at inlets and outlets.

.3 Ensure installation allows cleaning and maintenance without disturbing installed equipment or piping.

.4 Anchor heat exchanger with bolts and inserts.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Baseboard radiation.

.2 Convectors.

.3 Unit heaters.

.4 Heating fan coil units.

.5 Unit ventilators.

.6 Related accessories and specialities.

1.2 Quality Assurance

.1 Terminal heat transfer units shall be product of manufacturer regularly engaged in production of such products who issues complete catalogue data on such products.

1.3 Submittals

.1 Submit, in addition to shop drawings, schedules of radiation heating elements and enclosures indicating length and number of pieces of element and enclosure, corner pieces, and caps, cap strips, access doors, pilaster covers and a comparison of specified heat required to actual heat output provided.

2. PRODUCTS

2.1 General

.1 For each convection type heating unit not thermostatically controlled, provide knob operated internal damper at enclosure air outlet grille. Where group of rooms is zoned on one thermostat, provide dampers in each room.

.2 Factory apply backed primer coat on metal surfaces of enclosure or cabinet.

2.2 Baseboard Radiation

.1 Heating Elements: 20 mm nominal copper tubing mechanically expanded into flanged collars of evenly spaced 114 mm x 54 mm aluminium fins, one tube end belled.

.2 Enclosure: Minimum 24 gauge steel back panel, and 18 gauge steel top one piece front panel, end caps, corners and joiner pieces to snap together, front panel easily removable.

.3 Element Brackets: 1.2 mm galvanized steel to support front panel and noise free element cradle.

2.3 Unit Heaters

.1 Casing: 1.2 mm steel with threaded connections for hanger rods.

.2 Coils: Seamless copper tubing, 0.6 mm minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminium fins mechanically bonded to tubing.

.3 Fan: Direct drive propeller type, statically and dynamically balanced. Horizontal models complete with sleeve bearings and fan guard. Vertical model complete with grease lubricated ball bearings.

.4 Air Outlet: Adjustable pattern diffuser on projection models and four way louvres on horizontal throw models.

2.4 Heating Forced Flow Units

.1 Cabinet: 1.6 mm steel with rounded exposed corners and edges, easily removed panels, glass fibre insulation, integral air outlet and inlet grilles. Finish exposed surfaces in baked enamel of approved colour.

.2 Coils: Evenly spaced aluminium fins mechanically bonded to copper tubes, designed for maximum operating limits of 1380 kPa and 104°C.

.3 Fans: Centrifugal forward curved double width wheels, statically and dynamically balanced, direct driven, on sleeve bearings resiliently mounted.

.4 Filter: Easily removed 25 mm thick glass fibre throw-away or permanent washable type filtering air before coil.

.1 Provide key operated wall mounted wall thermostat switch where inaccessible.

3. EXECUTION

3.1 Installation

.1 Provide each unit with shut off valve on supply and lockshield balancing valve on return piping.

.2 Provide each unit at high points with easily accessible manual air vent. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing. For fan coil units, and unit heaters, provide float operated automatic air vents with stop valve.

.3 For inaccessible valves, provide factory permanently hinged access doors, 180 x 180 mm minimum size, integral with cabinet.

.4 Mount units with fans with rubber in shear isolators.

3.2 Performance

.1 Refer to schedule.

.2 Radiation and convector capacities are based on 18°C entering air temperature, 82°C average water temperature.

.3 Unit heater and fan coil capacities are based on 16°C entering air temperature, 82°C entering water temperature.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Horizontal, belt driven, cabinet model fan coil unit. Cabinet shall provide full access to internal components. Two pipe single coil or four-pipe dual coil (heat/cool) type as specified.

.2 Vibration isolation.

.3 Controls.

.4 Shop drawings.

1.2 Quality Assurance

.1 Each unit shall be CSA approved and labelled.

.2 Insulation and adhesive shall meet NFPA-90A requirements for flame spread and smoke generation.

2. PRODUCTS

2.1 General

.1 Factory assembled, horizontal or vertical blow-thru ducted fan coil unit. Unit shall be complete with water coil(s), fan(s), motor(s), drain pan, and all required wiring, piping, controls and special features.

2.2 Horizontal Base Unit with Plenum for Concealed Installation (42DC)

.1 Unit shall have a factory-installed, 18-gage galvanized steel plenum section and 1-in. throwaway filter. The plenum shall be either bottom or rear return, lined with ½-in. thick fiberglass Tuf-Skin II insulation and include a removable panel to provide access to the fan/motor assembly.

2.3 Fans

.1 Direct-driven, double-width fan wheels shall have forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel.

2.4 Coils

.1 Unit shall be equipped with a 4-row coil for installation in a 2-pipe system. All coils shall have ½-in. copper tubes and aluminum fins spacing; Coil fins are mechanical bonded to tube joints. The copper tubes comply with the ASTM B-75. The fin thickness is 0.0045-in. and tube thickness is 0.016-in. All coils are tested with air under water and are suitable for design working pressures of 250 psig at 220 F. Burst tested at 350 psig.

2.5 Controls and Safeties

.1 Unit shall be furnished with a 3-speed, 4-position fan switch on a wall plate for field mounting. The fan motor(s) shall be equipped with integral, automatic reset thermal overload motor protection.

2.6 Electrical Requirements

.1 Standard unit shall operate on 115-v, single-phase, 60-Hz electric power, and all exposed wiring shall be in a flexible conduit.

2.7 Motor(s)
Fan motors shall be 3-speed permanent split capacitor type, 115 volts, with sleeve type bearings and oversized oil reservoirs.

3. EXECUTION

.1 Install trapped drain line fabricated from type L copper tube. Slope drain away from unit and insulate.

.2 Install isolation valves in coil piping in accordance with valve manufacturer's instructions. Be sure valves are in proper operating position and are easily accessible for adjustment. Provide flow balancing valves on coil return pipes.

.3 Install unit on hanger rods with rubber-in-shear isolators.

.4 Supports, piping, conduit, etc. shall allow for proper access to access panels, filters, belts, etc.

.5 Provide flexible duct connections between unit and duct plenum.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Direct fired make-up air heater.

.2 Filter section.

.3 Controls.

.4 Shop drawings.

1.2 Quality Assurance

.1 Comply with local and Provincial Regulations and have C.G.A. and CSA approval and labelling.

.2 Factory test to check construction, controls and operation of unit and provide certification.

.3 Operationally test after installation and provide start-up checklist and performance test report for maintenance manual/commissioning manual.

2. PRODUCTS

2.1 General Construction

.1 Construct heater casing and components of 1.3 mm 18 Ga. steel panels, reinforced with structural angles and channels to ensure rigidity under normal handling. Provide access panels to burner and blower motor assemblies from either side of unit.

.2 Locate observation port on burner section of observing main and pilot flames.

.3 Insulate complete unit with 25 mm 24 kg/m^3 foil faced fibrous glass insulation.

.4 Finish casing and components with heat resistant baked enamel.

2.2 Filters

.1 Provide filter section complete with removable 50 mm thick fibrous glass disposable filters in metal frames.

2.3 Burner

.1 Provide raw gas burner suitable for natural gas and capable of modulating turn down ratio of 25:1. Burner assembly and gas piping arrangement to include electric modulating main gas valve, motorized shutdown valve, main and pilot gas regulators, pilot electric gas valve, manual shut-off valve, and pilot adjustment valve.

.2 Furnish gas burner with electrically ignited supervised pilot. Pilot automatically ignited by spark rod through high voltage ignition transformer.

.3 Provide motorized damper complete with end switch to prove position before fan starts and burner will fire.

2.4 Fan

.1 Provide statically and dynamically balanced centrifugal fan mounted on solid steel shaft with heavy duty self-aligning pre-lubricated ball bearings and V-belt drive with matching motor sheaves and belts.

2.5 Controls

.1 Pre-wired unit completely so connection of power supply and field wiring from unit to control panel shall make unit operative.

.2 Provide terminal strip for connection to BMS system.

.3 Interlock unit to start when exhaust fan is running. Interlock burner to operate when flow switch located in exhaust duct proves flow.

.4 Fan discharge thermostat shall control modulating gas valve to maintain supply air temperature with BMS reset.

.5 Interlock with carbon monoxide monitoring system to operate fan when pre-determined carbon monoxide concentration detected.

.6 Provide safety controls to provide correct air flow before energizing pilot and to sense pilot ignition before activating main gas valve.

.7 Provide auto reset low and high limit controls to maintain supply air temperature between setpoint and shut fan down if temperatures are exceeded.

.8 Provide purge period timer to delay burner ignition and automatically bypass low limit control.

.9 Provide heat lockout by ambient heat lock out control.

3. EXECUTION

3.1 Performance

.1 Refer to direct fired units schedule in the mechanical equipment section of this specification.

3.2 Installation

.1 Install units on vibration isolators or spring hangers.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Indirect fired make-up air heater.

.2 Filter section.

.3 Controls.

.4 Shop drawings.

1.2 Quality Assurance

.1 Comply with local and Provincial Regulations and have C.G.A. and CSA approval and labelling.

.2 Factory test to check construction, controls and operation of unit and provide certification.

.3 Operationally test after installation and provide start-up checklist and performance test report for maintenance manual/commissioning manual.

2. PRODUCTS

2.1 General

.1 Air handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled on site will not be considered equal. All equipment shall be pre-wired, and factory certified by an approved testing agency such as UL, CSA prior to shipment.

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

.1 Gas fired units shall also include high limit and combustion air flow switch.
.2 Factory installed and wired non-fused disconnect switch in CEMA/NEMA 1 configuration, or disconnect with integral door closure mounted on face of control panel.

2.2 Unit Construction

.1 Unit casing shall be of minimum 18 (1.3 mm) gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

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

.3 Units shall be provided with access doors to the following components: fans and motors; filters; dampers and operators; access plenums and humidifiers/wet cells/ electrical control panels; burner compartments; compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.4 Provide hinged access doors, fully lined, with a minimum of two camlock fasteners for all units up to 1220 mm high. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed. Hinged access doors shall be provided with tie back clips.

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

.6 All units shall be internally insulated with (25 mm) thick (24 kg./cu.m.) density, neoprene coated fibre glass thermal insulation

2.3 Fans

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans of 450 mm or less diameter, shall be equipped with permanently lubricated cartridge ball bearings, supported by a 3 point "spider" bearing bracket in the fan inlets. All other forward curved fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

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

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

.5 Provide standard approved belt guards on all units with walk in sections over 1524 mm high.

.6 All single phase belt drive motor applications shall include rubber isolation for motors ¼ H.P. through 1 ½ H.P. Provide internal spring isolation for single phase motors over 1 ½ H.P.

.7 Low limit discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

2.4 Gas Heat Section – Indirect Fired

.1 General

.1 Heating units shall be indirect natural gas approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.

.2 Heat Exchanger

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

.3 Burner

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

.2 Unit(s) shall include 15:1 turndown (HT burner) for all inputs in range 29.3 kw to 410 kw. The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on-off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from hi to lo fire.

.4 Venting

.1 Installation and venting provisions must be in accordance with C.G.A. Standards B149.1, ANSI Z223.1-NFPA54, and local authorities have jurisdiction. Type A, L, and/or PS venting is required on indoor units.

.5 Controls

.1 Heating control shall be modulating discharge air with 4-20 ma or 0-10 VDC. BMS reset. Minimum discharge air setpoint is 50°F (10°C) if BMS control fails.

2.5 Filters

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.

.2 Pleated Panel Disposable Filters:

.1 2" (50 mm) Non-woven cotton and synthetic fabric media with a metal support grid and rigid heavy-duty board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. The filter media shall have an efficiency of 25-30% on ASHRAE Standard 52.1-92, and minimum MERV 6 per ASHRAE 52.2.-1999.

3. EXECUTION

3.1 Performance

.1 Refer to indirect fired unit schedule in the mechanical equipment section of this specification.

3.2 Installation

.1 Install units on vibration isolators or spring hangers.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Centrifugal fans.

.2 Propeller fans.

.3 Fan accessories.

.4 Roof curbs.

.5 Bathroom exhaust fans.

.6 Kitchen range hoods.

.7 Cabinet fans.

1.2 Quality Assurance

.1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 CSA certified.

.3 Motors shall be per high efficiency specifications.

1.3 Submittals

.1 Submit with shop drawings, acoustical data and fan curves showing fan performance with fan and system operating point plotted on curves. Clearly blank out any irrelevant data on the shop drawings and highlight all changes from that specified.

1.4 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters in place, bearings lubricated and fan has been run under close supervision.

1.5 Alternates

.1 Equivalent fan selection shall not change motor wattage, increase noise level, increase tip speed by more than 10% or increase air velocity by more than 20%, from that specified.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide balanced variable sheaves for motors 15 HP and under and fixed sheave to 20 HP and over.

.3 Fans shall be capable of accommodating static pressure variations of + or - 10% with no objectionable operating characteristics.

.4 Provide motor bases with 2 screw adjustable motor base.

.5 Provide belt guard with tachometer ports for all belt drive fans.

.6 Provide variable volume devices (i.e. vanes, cone, speed, etc.) where indicated in schedules.

.7 Provide fan sound data when specified or requested by the Consultant.

.8 All fans, specified to be attached to ancillary equipment, silencers or canvas flexible connectors, shall come c/w flanged ends suitable for such connections.

.9 Bearings shall have a minimum L-10 life of 100,000 hours based on the maximum safe speed of the fan class.

.10 Where required, fans shall be treated to suit the airstream in which they are used.

2.2 Centrifugal Fans

.1 Fabricate with multi-blade wheels in heavy gauge steel housing reinforced for service encountered.

.2 Provide 1.5 service factor V-belt drives with fan and motor mounted or reinforced, rigid steel base with adjustable motor mount. Use minimum of two (2) belts.

.3 Provide heavy duty, self-aligning, anti friction bearings with external lubrication. Bearings shall be SKF Model SNA pillowblocks with V-seals.

.4 Provide access door and drain connections to scroll.

.5 Except for packaged air units, belted vent sets and as otherwise noted, centrifugal fans over 430 mm diameter shall have die formed air foil blades welded to side and back plate.

2.3 Propeller Fans

.1 Directly connect steel or aluminium blade fans with heavy hubs to motor.

.2 Motor shall have self-aligning ball or sleeve bearings with adequate lubricating arrangements.

.3 Mountings shall be cast or die formed to smooth curves. Supply size to fit openings provided.

.4 Provide safety screens in inlet and rattle free backdraft dampers with felt lined blade edges on outlet.

.5 Use neoprene vibration isolation between fan assembly and mounting plate.

2.4 Bathroom Exhaust Fans

.1 Provide multi-blade, forward curved wheel in steel housing for between stud mounting.

.2 Resiliently mount direct driven fan and motor. Motor shall be plug in type with permanently lubricated bearings.

.3 Provide wall switch and backdraft damper.

2.5 Kitchen Range Hoods

.1 Resiliently mount multi-blade direct driven fan and motor. Motor shall be two speed plug-in type with permanently lubricated bearings.

.2 Finish hood in baked enamel, with rocker type switches for light and two speed fan. Provide washable filter of aluminium mesh. Colour must be approved by the Architect.

.3 Provide backdraft damper.

3. EXECUTION

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screens.

.2 Provide belt guards with tach ports on belt driven fans.

.3 Supply and install sheaves as necessary for final air balancing.

.4 Flexible duct connections to fans shall be installed so that when operating, the inlet of the fan is not reduced or impeded.

.5 Provide one spare set of belts for each piece of equipment using belt drives.

3.2 Priming

.1 Prime coat, inside and outside, steel fan wheels and housing at factory. Prime coating on aluminium parts is not required.

.2 Provide two additional coats of epoxy paint on fans for main pool air handling unit.

3.3 Performance

.1 For performance based on sea level conditions, refer to Specifications for fan schedules.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Ductwork and plenums.

.2 Fasteners.

.3 Sealants.

.4 Duct cleaning (refer to Section 15850).

.5 Testing (refer to Section 15042).

.6 Firestopping and smoke seals. (Refer to Section 15580).

1.2 Definitions

.1 Low Pressure: Static pressure in duct less than 0.5 kPa and velocities less then 10 m/s.

.2 Duct Sizes on drawings indicate inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

.3 Sheet Metal and Air Conditioning Contractors National Association (SMACNA) details are referred to, illustrating construction and installation of ductwork, plenums and fittings.

.4 References to SMACNA manuals shall mean HVAC duct construction standards first edition 1985.

.5 Unless otherwise noted ducts shall be constructed to 50 mm W.G. rating.

1.3 Quality Assurance

.1 Ductwork shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems NFPA No. 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems and NFPA No. 96, Standards for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapours from Commercial Cooking Equipment.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

.3 Ductwork used on this project shall be clean and free from scale, corrosion and deposits. All ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.

.4 Where welded ductwork is indicated, the welding shall be continuous with Everdur welding. Tack welding is unacceptable except as specifically noted. Paint damaged areas with zinc coating after welding.

.5 The air distribution system shall be installed and adjusted to give comfort conditions with draft-free and quiet operation.

.6 All ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.

1.4 Submittals

.1 Submit shop drawings and samples of duct fittings for approval, including particulars such as thicknesses, welds, and configurations prior to start of work.

.2 Prior to construction of any ductwork, submit a schedule indicating the type of joints/gauges/bracing/fittings, etc.

1.5 Alternatives

.1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.

2. PRODUCTS

2.1 Materials

.1 Ducts: Galvanized steel lock forming quality, having galvanized coating to ASTM A525 G90 designation for both sides.

.2 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.3 Sealant: Water resistant, fire resistive, compatible with matching materials. Duct sealer shall be Duro Dyne S-2 c/w FT-2 tape Flexmaster duct band.

.4 Flexible Ducts: Corrugated aluminium or fabric supported by helically wound steel wire or flat steel strips, Fabriflex FAB4 or FAB4T.

.5 Prefabricated duct joints: Ductmate duct joints may be used for rectangular duct joints. Ductmate '35' shall be used with DC 35 corners which shall be bolted. Install metal cleats as ducts are assembled. Flanges are bolted to duct, minimum 2 per side, 600 mm centres, sealed with high velocity duct sealer.

.6 Support hangers and clips for hoods and ducts shall be of the same finish and material as the hood and/or duct.

2.2 Low Pressure Ductwork

.1 Construct low pressure ductwork and fittings in accordance with the following minimum SMACNA Standards.

- .1 Rectangular ductwork - Tables 1-5 through 1-9, use only long radius elbows or square elbows with turning vanes. Figs 1-5 through 1-18.
- .2 Round ductwork - Table 3-2, Fig.3.1 (RL-1 through RL-4 only).
- .3 Rectangular duct fittings - Figs. 2-1 to 2-10 and Figs. 2-16 to 2-19. For Fig. 2-8 use only 45 Deg entry, Conical and Bellmouth connections. For Fig 2-16 use volume extractor where neck length is less than 2 grille widths. Install cushion heads after diffuser take-offs. For Figure 2-9 minimum angles shall be 30^0 for diverging and 45^0 for converging.
- .4 Round duct fittings - Fig 3-3, 3-4 and 3-5 crimped joints and adjustable elbows are not permitted.

.5 Provide perforated metal liner for 3m downstream of fans with interior insulated ducts.

.6 Moisture collection sections shall have the bottom 150 mm of side joints and bottom joints continuously welded watertight. Provide a deep seal trap (40 mm greater than system static). Provide a watertight upturned seam at ends of collector. Collector shall be 1200 mm in length each side. Collector shall be constructed of 304 stainless steel.

2.3 Flexible Ductwork

.1 Flexible ductwork for air conditioning systems shall be as Fig 3-7 form M-I or form NM-IL conforming to NFPA 90A and UL-181 class 1 and as approved by local authorities.

.2 Ducts shall be limited in length to 1.5 m.

.3 Insulation shall have a vapour barrier and insulation with a "K" value of 0.033 w/m Deg C at 24 Deg C.

3. EXECUTION

3.1 Installation

.1 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.

.2 Locate ducts with sufficient space around equipment to allow normal operating maintenance activities.

.3 Increase duct sizes gradually, not exceeding 15 degree divergence wherever possible. Maximum divergence upstream of equipment to be 30 degree and 45 degree convergence downstream.

.4 Provide drip pans under piping and shields for protection of electrical panels and equipment.

.5 Install sleeves in walls and floors with 18 gauge galvanized steel. Extend floor sleeves 50 mm above floor. Leave 12 mm gap between ducts or insulated ducts and sleeve.

.6 Where ducts penetrate roofs, install sleeves and roof curb. Provide flashing and counterflashing.

.7 Cover exposed duct sleeves and openings in exposed areas with 1.2 mm (18 gauge) galvanized steel angle collars. Extend collar 25 mm down side of curbs. Fix collar in position with cadmium plated screws.

.8 Install ductwork in the space provided. Keep ductwork clear of lights, sprinklers, drains, pipes, etc. Co-ordinate the work with other trades.

.9 Prior to the fabrication of ductwork, this Contractor shall co-ordinate and field measure all ductwork to ensure a complete installation respecting all other

services. Provide all necessary fittings, offsets, and alternate construction methods to facilitate the installation.

.10 Provide moisture collection sections inside all louvres for outside air and exhaust air.

.11 Keep duct clean during construction. Cover open duct ends with polyethylene for ducts smaller than 0.4 m^2 in area. Larger ducts and vertical shall be capped with metal.

.12 Make joints so that ducts will not pull apart (except at fire dampers).

.13 Unless noted otherwise, line all builder's shafts and air plenums used as ducts and plenums with sheet metal.

.14 Provide firestopping and smoke seals. See Section 15580.

3.2 Flexible Ductwork

.1 Install flexible ductwork where indicated on the drawings and as specified.

.2 Provide intermediate supports for flexible ducts so that sagging does not occur. Very sharp turns and reduction in the area of the duct will not be permitted.

.3 Connect to ductwork, diffusers, and terminal units with stainless steel worm drive clamps, adjustable clamps or duct straps applied over two wraps of duct tape.

.4 Provide insulated ductwork for high and medium pressure ducts. Un-insulated ducts may be used for run-outs to diffusers unless otherwise noted.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Site fabricated breechings.

.2 Manufactured chimneys for atmospheric gas fired equipment.

.3 Manufactured chimneys for forced draft natural gas fired equipment.

.4 Refractory line stacks for incinerators.

1.2 Quality Assurance

.1 Comply with Provincial Regulations and have CSA approval.

.2 Comply with appliance manufactures certification equipment.

1.3 Labelling

.1 Chimneys: Labelled by Underwriter's Laboratory of Canada.

2. SCOPE OF WORK

2.1 Products

.1 Breeching Gaskets: High temperature non-asbestos material, "fibrefax" or equal.

.2 Breeching: Welded black steel sheet, suitably reinforced.

.3 For natural draft and approved neutral vent pressure appliance: Selkirk Type DF (Type B) c/w stainless steel inner lining. Provide stainless steel outer jacket for outdoor exposed section of the flue.

2.2 Fabrication

.1 Fabricate unlined breeching of following thickness sheet: under 300 mm dia. - 1.3 mm to 610 mm dia. - 1.6 mm, 640 mm to 910 mm dia. - 2.0 mm; 940 mm to 1520 mm dia. - 3.0 mm.

.2 Fabricate lined breeching of 3.0 sheet.

.3 Provide properly sized barometric damper on breeching as required.

.4 Fabricate chimney with baseplate, anchors, cleanout, provision for support, expansion and contraction, tee-sections, flashing and counterflashing and raincap.

3. EXECUTION

3.1 Installation

.1 Suspend breeching using trapeze at 1.5 m centres. Provide hinged inspection doors with gasket and locking device.

.2 Provide properly sized barometric damper on breeching as required.

.3 Provide stacks with fly ash screen. Support stacks at bottom, roof and intermediate levels.

.4 Install breeching and chimney with positive slope back to appliance.

END OF SECTION

1. GENERAL

1.1 Installation Description

.1 Furnish and install a Modulating Draft System with all components and accessories as shown on the drawing and as specified including the following:
- .1 Combination of chimney draft inducer or blower with controls; listed as a complete system to UL-378, "Standard for Draft Equipment"
- .2 Electrical Wires and Connections
- .3 Communication Wires and Connections
- .4 Vent Pipe Transitions and Draft Inducer or Blower Connections

1.2 Codes And Standards

.1 The installation must comply with all sections of this specification along with all local building codes, tests or recommended methods of trade, and:
- .1 The National Fuel Gas Code
- .2 The National Electrical Code

1.3 Quality Assurance

.1 Modulating Draft System shall be of a standard catalog product and must be manufactured in North America. The chimney fan/control must have more than 1,000 similar systems installed and operating in North America.

.2 Scheduled equipment performance is minimum capacity required.

.3 Scheduled electrical capacity shall be considered as maximum available.

1.4 Submittals

.1 Modulating Draft System manufacturer and/or its representative(s) shall provide product data submittal sheets and drawings indicating vent layout and design calculations, which shall serve as the basis for system evaluation by consulting engineer.

.2 Submit the following to the building owner's representative (as requested):
- .1 Chimney draft inducer or blower description, dimensional diagram(s) and electrical diagram(s).
- .2 Control description, dimensional diagram(s) and electrical diagram(s).
- .3 Specification review with respect to submitted equipment identifying all exceptions to Specification.
- .4 Certification of Listing by nationally recognized testing laboratory.

1.5 Operating And Maintence Manuals

.1 Provide to building owner's representative complete *Operation and Maintenance* manuals on the chimney draft inducer or blower and controls in addition to dimensional diagram(s) and wiring diagram(s).

2. PRODUCTS

2.1 Manufacturers, Modulating Draft System

.1 Furnish Tjernlund Products Modulating Draft System(s) with design volume and pressure as scheduled and specified. Alternate manufactures complying with plans and specifications must be submitted and approved by the Consulting Engineer within 10 days prior to bid date.

2.2 Modulating Draft System

.1 Chimney Draft Inducer (applicable to VSAD-Series only)

.1 The outdoor mounted chimney draft inducer shall have six sides with vertical discharge, manufactured of Type 5052 aluminum with a minimum thickness of 1/8". Housing must be resistant to corrosion and be protected by Ryton® polyphenylene sulfide.* The chimney draft inducer must be ETL Listed to UL378 for temperatures up to 500° F in the United States and 575° F in Canada, measured at the chimney termination point, regardless of speed of operation. The chimney draft inducer shall be Listed for both vertical and sidewall vent terminations.

.2 The backward inclined impeller shall be made from type 304 stainless steel and be both dynamically and statically balanced with permanently attached balancing weights.

.3 The three phase motor shall be inverter rated for variable speed and have permanently lubricated, sealed ball bearings. The motor shall have a thermally activated, external cooling fan that effectively cools motor bearings and windings regardless of speed of operation.

.2 Constant Pressure Controller (CPC-3)

.1 The constant pressure controller must be microprocessor based and capable of maintaining a constant draft, measuring within .001" w.c. of set-point. It must have integral braking capabilities that will slow the chimney fan to a complete stop after the call for heat has been satisfied. Additional standard features:

.1 Choice of manual or automatic operation
.2 Vacuum florescent 80-character Display providing continuous system status
.3 User programmable, soft touch keypad
.4 Independent operation of separate draft and combustion air systems with one controller
.5 Ability to output to and interlock with a motorized louver
.6 Adjustable pre-purge and post-purge, up to 30 minutes
.7 Appliance interlock circuits compatible with millivolt, 24 volt, 115 volt or 230 volt burner circuits
.8 Plug in up to three expansion modules (EXP-4E) via provided ribbon cables to interlock with a total of 16 appliances
.9 LED status indicators on the face of the keypad showing individual status of each heating appliance
.10 Allow retrieval of fault codes for easy troubleshooting
.11 Ability to reset variable frequency drive faults from the remote mounted CPC-3

.2 If the chimney fan cannot achieve the pressure set-point, the constant pressure control must disrupt the appliance burner(s) and Modulating Draft System. The constant pressure control shall make a second attempt for the Modulating Draft

System to reach the pressure set-point. If unable to reach set-point, the constant pressure controller shall prevent operation of all interlocked burners.

.3 Pressure Transducer (TD-2)

.1 Pressure Transducer must have automatic re-calibration to prevent drift from 0.00" w.c. reference. It shall have a sensing range between +0.15" to –0.60" w.c. and plug in connection to facilitate job site wiring. Vent layout must include a 'Tee' fitting for the vent pressure sampling tube, as per the manufacturer's instructions. All wires between the TD-2 and CPC-3 must be in dedicated conduit and may not share a junction box with any other wiring.

.4 Variable Frequency Drive (VFD-2HIA122C3)

.1 VFD must use pulse width modulation, varying both voltage and frequency. VFD must be factory programmed for the chimney draft inducer or blower that it is controlling. It must include a ten-wire communication cable that plugs into the VFD terminal strip to facilitate job site wiring. VFD shall be housed in an 18 gauge metal, powder coated enclosure.

.5 Balancing Baffles ((7)ABD-8, (2)ABD-6, ABD-10)

.1 Supply an ABD-Series Balancing Baffle manufactured of type 304 stainless steel for each heating appliance interlocked into the Modulating Draft System. Baffles must be equipped with a position locking mechanism to be fixed at time of system commissioning.

.6 Vent Pipe Transitions and Draft Inducer or Blower Connections

.1 Furnish type 5052 aluminum mounting plate, inlet collar, wall mounting kit or stainless steel collector box as shown on drawings.

.7 Expansion Modules ((2)EXP-4E)

.8 Roof Mounting Kit (RMK-12)

2.3 ELECTRICAL REQUIREMENTS

.1 Power supply to the VFD: 208 volt.

.2 Power supply to the CPC-3 control: 208 volt supplied by VFD.

.3 Power supply to the chimney draft inducer or blower: 208 volt supplied from VFD.

.4 All wiring must be in metal conduit.

.5 Do not run the VFD's input power and output power wires in the same conduit or undesired VFD operation could result.

.6 If required, non-fused disconnects are to be supplied by the installer.

.7 All wiring shall be in accordance with The National Electrical Code.

.8 All installations must use the provided communications cable to interface the CPC-3 and VFD. Any installer added sections of field wiring shall maintain color coding and/or be labeled at each end.

.9 VFD input power may be different then VFD output power.

2.4 Control Wiring

.1 Division 15 contractor shall provide;
- .1 Low voltage wiring between CPC-3 controller and VFD.
- .2 Interlock wiring to all gas appliances from CPC-3 controller.
- .3 Wiring from inducer proving switch to CPC-3 controller.
- .4 Interlock from refrigerant gas detection controller to CPC-3 controller.

2.5 Draft Inducer/Blower Schedule

Unit No.	Service	Location	Cfm	Static Pressure In. Wg.	Rpm	H.P.	Volts	Ph	Hz	Basis Of Design
1	Water Heaters & Makeup Air Units	Ground Floor Mechanical Room	2673	1.02	Variable	2.0	230	3	60	Tjernlund Vsad12-230

3. EXECUTION

3.1 Installation

.1 Perform all mechanical and electrical connections in accordance with specification drawings and manufacturers' printed instructions. Modulating Draft System includes all components listed above with the accompanying low voltage and high voltage electrical wiring, as well as, low voltage communications wiring per Tjernlund Products supplied schematic(s). Install vent pipe transitions and draft inducer or blower connections, type 5052 aluminum mounting plate (VSAD-Series), inlet collar, wall mounting kit and stainless steel collector box, as shown on drawings.

3.2 Modulating Draft System Commissioning

.1 Modulating Draft System distributor shall supply service technicians having experience in system start-up, troubleshooting and preventative maintenance. After Installation is completed:
- .1 Verify all electrical and communications wiring connections
- .2 Test run the operation of the Modulating Draft System
- .3 Test safety interlocks

3.3 Operating Instructions

.1 Instruct owner's representative and designated personnel in the proper operation and maintenance of the Modulating Draft System.

3.4 Manufacturer's Warranty

.1 All equipment shall carry a two year warranty against defects in materials and/or workmanship. Chimney draft inducer or blower shall also carry a ten year corrosion perforation warranty on the housings.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Access doors.

.2 Fire dampers.

.3 Fire/smoke dampers.

.4 Balancing dampers.

.5 Backdraft dampers.

.6 Flexible connections.

.7 Turning vanes.

.8 Firestopping and smoke seals (refer to Section 15580).

1.2 Quality Assurance

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S112 "Fire Dampers."

.2 Fusible links on fire dampers shall be constructed to ULC Standard S505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

.4 Access doors shall be ULC labeled.

.5 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems and NFPA 92A.

.6 Fabricate and install in accordance with SMACNA HVAC Duct Construction Standards, First Edition 1985 and SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, Third Edition 1986.

1.3 Submittals

.1 Submit shop drawings of factory fabricated assemblies.

.2 Submit samples of shop fabricated assemblies requested.

2. PRODUCTS

2.1 Access Doors

.1 Fabricate as per Fig. 2-13 for round ducts and Fig. 2-12 with frame 2, lock 1, piano hinge, and door A and Fig 2-14 rolled hinge. Use 25 mm insulated door with metal liner for insulated ducts.

.2 Access doors shall be 450 x 450 unless otherwise indicated or required by duct size.

.3 Access doors for kitchen exhaust ductwork shall be constructed of the same material and gauge as the ductwork. Doors shall be liquid and air tight.

.4 Access panels shall be Nailor-Hart medium pressure 25 mm insulated, Model 0850-1 for rectangular duct and Model 0895 for round ducts. Panels shall be minimum 430 x 630 unless dictated by duct size.

.5 Ductwork: Nailor Industries 800 series insulated duct access doors with gaskets and camlocks, stainless steel in stainless steel ducts.

2.2 Fire Dampers

.1 Fabricate of galvanized steel or prime coated black steel weighted to close and lock in closed position when released by fusible link.

.2 Fire dampers in low pressure ductwork may be multi blade or curtain type.

.3 Fabricate combination fire and balancing dampers with linkage readily adjustable in open position.

.4 Curtain fire dampers shall have blades retained in a recess so free area of connecting ductwork is not reduced.

.5 Fusible links shall be set for 72°C.

2.3 Balancing Dampers

.1 Fabricate of galvanized steel, minimum 1.6 mm and provide with quadrants or adjustment rod and lock screw.

.2 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.

.3 Fabricate single blade dampers for duct sizes to (240 x 760 mm) (300 x 1200 mm).

.4 Fabricate multi blade damper of opposed blade pattern with maximum blade sizes 300 x 1800 mm. Assemble centre and edge crimped blade in prime coated or galvanized channel frame with approved type hardware.

.5 Construct damper blades for medium and high pressure systems to block air pressure 70% maximum. Provide complete with locking handles.

.6 Fabricate multi blade, parallel action gravity backdraft dampers with blades and maximum of 150 mm width having felt or flexible vinyl sealing edges, linked together in rattle free manner and with adjustable devices to permit setting for varying differential static pressure.

.7 Use sleeve bearings for shaft length greater than 400 mm.

2.4 Turning Vanes

.1 Use Airfoil type only complete with runner channels. Use acoustic insulation packed types with perforated metal shapes in lined ductwork applications.

2.5 Flexible Connections

.1 Install equipment flexible connections of approved fabric in accordance with Section 15160 and Fig. 2-19.

.2 Ensure that flex does not reduce fan inlet area or impede airflow.

.3 Ensure flex allows movement of equipment without affecting ductwork.

2.6 Backdraft Dampers

.1 Fabricate dampers of aluminium, frame shall be minimum of 0.81" and the blades shall be minimum .070" thickness.

.2 Axles must be minimum of 1/2" diameter synthetic with dustproof ball bearing pressed into the frame.

.3 Blade seals shall be an extruded vinyl seal locked in the blade edge.

.4 Dampers shall be complete with adjustable counterbalances.

3. EXECUTION

3.1 Application

.1 Provide adequately sized access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Review locations prior to fabrication.

.2 Provide 100 x 100 mm quick opening access doors for inspection at balancing dampers.

.3 Provide fire dampers at locations shown (+10%) 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.

.4 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

.5 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing.

.6 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and where indicated on the drawings.

.7 Install fire dampers in closed position. Contractor shall open fire dampers before fan systems are started.

.8 Install backdraft dampers on all exhaust and relief openings through the building walls and roof.

.9 Provide firestopping and smoke seals (see Section 15580).

3.2 Access Doors

.1 Provide access doors where indicated on drawings, where specified or required for equipment maintenance.
- .1 At all fire dampers to provide ready access to fusible links.
- .2 For smoke detectors, See Division 16.
- .3 For all equipment mounted in the ductwork.
- .4 Where required for cleaning, including every 10 m in all duct systems at changes in direction and at the base of all risers.
- .5 Provide access doors at duct mounted probes.
- .6 Provide access doors on the upstream and downstream side of all coils, turning vanes and fans.
- .7 Provide access doors on both sides of three (3) hour fire dampers.

3.3 Fire Dampers

.1 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.

.2 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

.3 For smoke dampers, provide a bead of FS 2000 between the angle iron frame and both the duct and wall to provide a smoke-proof barrier.

.4 Test and prove maximum response times. Provide test sheet for each damper.

3.4 Balancing Dampers

.1 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing.

.2 Provide balancing dampers at each run out to a grille or diffuser.

.3 Provide balancing dampers on high pressure systems where indicated. Splitter dampers shall only be used where indicated on the drawings.

3.5 Backdraft Dampers

.1 Provide backdraft dampers on all exhaust fans where control dampers are not called for or indicated.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Diffusers.

.2 Grilles and registers.

.3 Outside louvres.

.4 Door grilles.

.5 Diffuser boots.

.6 Roof hoods.

.7 Goosenecks.

1.2 Quality Assurance

.1 Air flow and sound level measurement(s) shall be made in accordance with applicable ADC equipment test codes and ASHRAE Standards.

.2 Unit ratings shall be approved by ADC.

.3 Manufacturer shall certify catalogue performance and ensure correct application of air outlet types.

1.3 Job Conditions

.1 Review requirements of inlets/outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of inlets/outlets.

.2 Positions indicated are approximate only. Check location of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

2. PRODUCTS

2.1 General

.1 Base air outlet application on space noise level of NC 30 maximum.

.2 Provide baffles to direct air away from the walls, columns or other obstructions within the radius of diffuser operation.

.3 Provide plaster frame for diffuser located in plaster surfaces.

2.2 Supply Grilles

.1 Sidewall supply grilles shall have streamlined and individually adjustable blades, depth of which exceeds 20 mm maximum spacing. Provide spring tension or other device to set blades. Provide units with vertical or horizontal face, double deflection bar style grilles as specified.

.2 Provide 32 mm margin frame with (countersunk screw holes) (concealed fastening).

.3 Provide grilles with integral, gang-operated opposed blade dampers with removable key operator, operable from face.

.4 Finish in factory (baked enamel) (prime coat) finish.

2.3 Louvred Supply Grilles

.1 Ceiling supply grilles shall have streamlined and individually adjustable curved blades to discharge air along face of grille. Units shall have two-way deflection.

.2 Provide 32 mm margin frame with (countersunk screw holes) (concealed fastening).

.3 Fabricated of heavy aluminium extrusions.

.4 Provide grilles with integral, gang-operated opposed blade dampers with removable key operator, operable from face.

.5 Finish in factory (clear lacquer) (prime coat) finish.

2.4 Linear Supply Grilles

.1 Linear supply grilles shall have streamlined blades with (0°) (15°) deflection, 3 x 20 mm on 6 mm centres.

.2 Fabricate of heavy aluminium extrusions.

.3 Provide 32 mm margin frame (extra heavy for floor mounting), with (countersunk screw holes) (concealed fastening).

.4 Provide grilles with integral gang-operated opposed blade damper with removable key operator, operable from face.

.5 Provide mounting frame suitable for casting in concrete floor where required.

2.5 Floor Supply Grilles

.1 Floor grilles have individually adjustable blades, wide stamped border, single or double blade damper with set screw adjustment.

.2 Fabricate of steel, welded construction.

.3 Finish in factory baked enamel finish.

.4 Provide grilles with integral gang-operated opposed blade damper with removable key operator, operable from face.

2.6 Return and Exhaust Grilles

.1 Sidewall and ceiling exhaust grilles shall have streamlined blades, depth of which exceeds 20 mm spacing. Provide spring tension or other device to set blades. Provide units with horizontal face.

.2 Provide 32 mm margin frame with (countersunk screw holes) (concealed fastening).

.3 Fabricate of (steel with 1.0 minimum frames and 0.8 mm minimum blades), (steel and aluminium 1.0 mm minimum frame), (or heavy aluminium extrusions).

.4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face.

.5 In gymnasiums, blades shall be front pivoted, welded in place or securely fastened to be immobile.

.6 Finish in factory (baked enamel) (prime coated) finish.

2.7 Grid Core Return and Exhaust Grilles

.1 Fabricated fixed grilles of 12 x 12 mm louvres.

.2 Provide 32 mm margin frame with (countersunk screw holes) (lay-in frame for suspended grid ceilings) (concealed fastening).

.3 Fabricate of aluminium.

.4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed dampers with removable key operator, operable from face.

2.8 Linear Return or Exhaust Grilles

.1 Linear return or exhaust grilles shall have streamlined blades with (0 deg) (15 deg) deflection, 3 x 10 mm on (6 mm) (12 mm) centres.

.2 Provide 32 mm margin frame (extra heavy for floor mounting), with (countersunk screw holes) (concealed fastening).

.3 Fabricate of (steel with 1.0 mm minimum frames with 0.8 mm minimum blades), (steel and aluminium with 1.0 mm minimum frame), (or heavy aluminium extrusions).

.4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face.

.5 Provide mounting frame suitable for casting in concrete floor where required.

2.9 Round Supply Diffusers

.1 Provide round, adjustable pattern, stamped or spun, multi-core type diffuser to discharge air in 360° pattern, with sectorized baffles where indicated or required.

.2 Provide diffuser collar not more than 25 mm above ceiling face and connect to duct with duct ring.

.3 Fabricate of steel with baked enamel finish.

.4 Provide (radial opposed blade) (butterfly) (combination splitter) damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

.5 Provide 2 eyes on diffuser for attachment of seismic restraints.

2.10 Rectangular Supply Diffuser

.1 Provide rectangular, adjustable pattern, stamped, multi-core type diffuser to discharge air into 360° pattern sectorizing baffles where indicated or required.

.2 Diffusers shall have (surface mount) (snap-in) (inverted T-bar) (spline) type frame.

.3 Fabricate of steel with baked enamel (off white) finish.

.4 Provide (radial opposed blade) (butterfly) (combination splitter) damper with damper adjustable from diffuser face if inaccessible ceiling.

.5 Provide two (2) eyes on diffuser for attachment of seismic restraints.

2.11 Perforated Face Diffusers

.1 Provide perforated face diffuser with fully adjustable pattern and removable face.

.2 Diffuser shall have (surface mount) (snap-in) (inverted T-bar) (spline) type frame.

.3 Fabricate of steel with (steel) (or aluminium frame) and baked enamel (off white) finish.

.4 Provide (radial operated blade) (butterfly) (combination splitter) damper with damper adjustable from diffuser face if inaccessible ceiling.

.5 Provide 2 eyes on diffuser for attachment of seismic restraints.

2.12 Modified Light Troffer Diffusers

.1 Light troffer diffusers shall be (single) (double) plenum type constructed independent of light troffers with volume and pattern controllers, 100 mm, 125 mm, 150 mm round or oval (top) (side) air inlet.

.2 Match diffusers to troffers and connect in airtight connection without tools.

.3 Fabricate of galvanized steel with welded or soldered joints and finish matt inside.

.4 Provide 2 eyes on diffuser for attachment of seismic restraints.

2.13 Door Grilles

.1 Fabricate of V-shaped louvres of 1.0 mm steel, 25 mm deep on 12 mm centres.

.2 Provide 1.0 mm steel frame with auxiliary frame to give finished appearance on both sides of door.

.3 Factory finish in prime coating.

2.14 Outside Louvres

.1 Louvres (100 mm) (150 mm) deep with blades on 45 deg. slope with centre baffle and return bend, heavy channel frame, birdscreen with 12 mm square mesh for exhaust and 25 mm for intake.

.2 Fabricate of 3.0 mm extruded aluminium and provide welded assembly.

.3 Finish in factory (prime coat) (baked enamel) (colour anodized) finish.

.4 Fabricate louvred penthouses with mitred corners and sheet roof reinforced with structural angles.

.5 Blank-off panels shall be constructed to SMACNA standards, minimum 20 Ga with 25 mm fibreglass insulation.

.6 All blank-off panels shall have a painted flat black enamel finish.

2.15 Roof Hoods

.1 Air inlets or exhaust hoods shall have removable hood, curb flange and birdscreen with 12 mm square mesh for exhaust and 25 mm for intake.

.2 Fabricate of (galvanized steel, minimum 1.6 mm and 1.0 mm hood) or (aluminium minimum 1.6 mm base and 1.2 mm hood). Provide 25 mm insulation and suitable reinforcing to hood.

.3 Mount unit on minimum 300 mm high curb base with insulation between duct and curb.

.4 Finish in factory (baked enamel) finish.

.5 Hood outlet area shall be minimum twice throat area.

2.16 Goosenecks

.1 Fabricate goosenecks of minimum 1.2 mm galvanized steel.

.2 Mount on minimum 300 mm high curb base where size exceeds 230 X 230 m.

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matt black.

3.2 Sizing

.1 Size outside air openings as indicated on drawings.

.2 Size air outlets as indicated on drawings.

.3 Provide blank-off panels for all unused louvres.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Provide complete system of automatic controls.

.2 Provide electric/electronic control system.

.3 Provide control devices, components, wiring and materials.

.4 Provide instructions for Owners.

.5 Examine all drawings and all sections of the specification for requirements and provisions affecting the work of this section.

1.2 Description of Work

.1 General

.1 The work under this contract shall include all labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and include items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or essential for proper operation of all systems related to this section, as indicated on the drawings and specified herein.

.2 Minimum Requirements

.1 The specification and drawings describe the minimum requirements that must be met by the Automatic Temperature Control (ATC) Contractor for the installation of all work as shown on the drawings or as specified herein under.

1.3 Incidental Work By Others

.1 The following work, related to this system is by others:

.1 All mechanical equipment; chillers, pumps, cooling towers, condensers, AHU's fans, boilers, etc. is furnished and installed by others.

.2 All HVAC ductwork furnished and installed by others.

.3 All piping and valves (unless specified otherwise)

.4 Control valves and control dampers shall be furnished by this contractor to be installed by others.

.5 All wells, taps, openings in piping and ductwork for monitoring devices, flow switches, flow measuring stations, etc.

.6 Hand-Off-Auto (HOA) switches for equipment operation shall be installed and tested prior to being hooked up the Temperature Control system.

.7 Power wiring to motors, starters and control panels shall be by section 16000.

1.4 Scope

.1 Provide all materials, labor, equipment, tools, appliances, services, hoisting, scaffolding, support and supervision for the furnishing and installing of all the ATC work and all related work complete, in accordance with the contract documents.

1.5 Quality Assurance

.1 Established Manufacturer
- .1 Shall be a firm regularly engaged in the manufacturer of DDC control equipment and computerized building systems similar to the specified equipment and has been in similar service for not less than 5 years. The contractor shall be prepared to provide evidence of this history as condition of acceptance and approval prior to bidding.

.2 Service Capability
- .1 The ATC contractor shall be regularly engaged in the engineering, programming, installation and service of ATC systems of similar size and complexity and shall have a separate service organization of at least five competent full time service personnel.

.3 Response Time
- .1 Provide the following as a minimum:
  - .1 During the warranty period, four hours or less, 24 hours a day, 7 days a week.
  - .2 The ATC contractor shall have a local branch facility with-in a 100 mile radius of the project site. Emergency service shall be available 24 hours a day, 7 days a week.

.4 Codes and Standards
- .1 Meet the requirements of all applicable standards and codes, except where more detailed or stringent requirements are indicated by the contract documents.
  - .1 UL - 916 PAZX (Energy Management)
  - .2 UL - 864 UDTZ (General Utility Signalling)
  - .3 UL - 864-UUKL (Smoke Control)
  - .4 National Electrical Code
  - .5 NFPA 92A, as applicable
  - .6 FCC-Part 15 Subparagraph J, class A
- .2 All wiring shall comply with the requirements of applicable portions of division 16 and all local and national electrical codes.

1.6 Submittals

.1 Basic Requirements
- .1 Contractor shall provide shop drawings and manufacturer's standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until submittals have been reviewed by the Engineer for conformity with the plans and specification. Six copies are required for submission. All shop drawings shall be done on AutoCAD and provided on a compact disc.

.2 Submittal Contents
- .1 Submit the following within (60) days of contract award:
  - .1 A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
  - .2 A schedule of all control valves indicating size, configuration, model #, flow, CV, pressure ratings and locations
  - .3 A schedule of all control dampers indicating size, blade configuration, extended shaft or frame mounting, FPM rating,

seals, bearing type, number of sections, number of actuators, etc.

.4 Provide manufacturer's cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted.

.5 Provide descriptive sequences detailing all control work.

.3 Diagrams

.1 Mechanical system line diagram shall include:

.2 Mechanical Components present but not necessarily affected by the ATC (i.e., Filters, smoke detector, circulating pump, etc.)

.3 Motor operated dampers, fail safe position, their locations and number of motors.

.4 Control valves, fail safe position, configuration, etc.

.5 Other Controlled devices

.6 All factory and field mounted sensors, start/stop relays, status relays, etc.

.4 Control Panels

.1 Panel-mounted control component representation.

.1 Face layout (as applicable)

.2 Interconnecting electrical wiring diagrams detailed in a one line diagram format (complete with terminal designations) on the same drawing

.5 Starter Interlocks

.1 Starter electrical wiring diagrams showing interlocks between the ATC system, the respective starter and any other interlocks not necessarily provided as part of the ATC system

.6 Room & Valve Schedule

.1 Provide as follows:

.1 Room number

.2 System name

.3 Reference drawing

.4 Device model number

.5 Valve size, CV and model number

.7 Sequence of Operation

.1 Provide a detailed sequence of operation for each system under control. This sequence shall be specific for the use of the control system being provided for this project.

.8 Input/Output List

.1 Provide a points list showing all system objects clearly and the proposed English language descriptors and point address, including all software points.

.9 Graphics

.1 Provide prints of proposed graphics with the associated points display.

1.7 As Builts

.1 Submit (6) manuals in accordance to Division 1. Manuals shall be bound in hardcover 3-ring binders and shall include the following as a minimum:

.1 Record Drawings
.2 Set of operating instructions, identifying the procedures to be employed to perform system operations.
.3 Information detailing preventive maintenance to be performed by the owner
.4 Subcontractors system guarantee and system component warranties. Itemized list verifying that all equipment provided and installed per this contract has been properly set-up to operate according to the specification.
.5 Include documentation listed in Section III, Execution.

1.8 Intent of Drawings and Specifications

.1 Intent
.1 The implied and stated intent of the drawings and specification is to establish minimum acceptable quality standards for materials, equipment and workmanship and to provide a complete and operable control system.

.2 Drawings
.1 The drawings are diagrammatic intending to show a workable general arrangement and location of system components and are not necessarily complete or rigid in all details.

.3 Sequence
.1 No deviation in the specified sequence of operation will be allowed without written approval from the engineer.

1.9 Codes and Permits

.1 Install all work in full accordance with the requirements of all local and government agency's having jurisdiction over these matters, as well as any requirements of NFPA, UL, and other applicable agencies. Secure and pay for all necessary approvals, permits, inspections, carting, legal dumping, etc., and deliver the official records of the granting of permits to the owner with no additional cost to the owner.

2. PRODUCTS

2.1 General

.1 Provide control system consisting of thermostats, control valves, dampers, operators, indicating devices, interface equipment and other apparatus required to operate mechanical system and to perform functions specified.

.2 All components shall be labelled according to as-built control drawings.

.3 Provide necessary materials and field work necessary to connect control components factory supplied as part of equipment that control, unless specified otherwise.

.4 Locate all remote controllers and relays within hinged cabinets.

2.2 Hardware

.1 PC Station

.1 The EMS computer shown on the plans or indicated elsewhere, shall include the following as a minimum:

.1 Personal Computer – 586/100 MHz or higher Intel®-based processor with 256 cache RAM

.2 32 MB of RAM, a 500 MB hard drive, and Multitasking software

.3 15" 800 x 600 super VGA non-interlaced color monitor

.4 3.5" floppy drive (1.44 Mbytes) plus an EIDE CD-ROM compatible with the operating system.

.5 One parallel, serial, mouse port, mouse and keypad.

.6 Report & Alarm Printer (See plans for exact requirements)

.2 Field Installed Controller

.1 The Field Installed Controller shall be a solid state sixteen bit micro-controller with pre-tested and factory configured software specifically designed for regulating building equipment using closed-loop Direct Digital Control and facility management routines.

.3 General Purpose Electronic Controller (GPEC)

.1 The GPEC shall be located where shown on the plans and shall include inherent input/output capability. Each controller shall include a minimum of eight inputs and eight outputs. If the GPEC's input/output capability is exceeded, additional controllers with inherent input/output capability shall be provided. The GPEC's input/output capability shall include a combination of standard HVAC sensor input and output types. The GPEC shall support discrete and either 0–10 VDC and 4–20 ma type analog outputs. The GPEC shall support the following sensor input types as a minimum:

.1 Dry contact and pulsing dry contacts

.2 0–10 VDC and 4–20 ma

.3 5K and 10K thermistors

.4 1000 ohm Nickel RTD

.2 Communication status for the primary communications bus and Local Interface Device (LID) shall be indicated by LED's. The separate LED's shall flash whenever communications are occurring. The GPEC shall communicate to all connected points at least once a second.

.3 The GPEC shall not require wiring to a terminal strip and shall utilize "plug type" terminals such that the user may be able to disconnect and replace a module simply by removing the plug type connectors and plugging them into a new module.

.4 General Purpose Electronic Expandable Controller (GPEX)

.1 The GPEX shall be located where shown on the plans and shall include inherent input/output capability. Each GPEX shall include a minimum of eight inputs and eight outputs. If the GPEX's input/output capability is exceeded, the GPEX shall be capable of supporting additional GPEX-I/O modules. Each GPEX-I/O module shall be capable of supporting a minimum of eight additional inputs and outputs. The GPEXs and associated GPEX-I/O modules shall include the ability to support a combination of universal HVAC sensor input and output types. The GPEX and GPEX-I/O modules shall include the inherent ability to support any combination of discrete, 0–10 VDC and 4–20ma outputs and the following sensor inputs types as a minimum:

.1 Dry contact and pulsing dry contacts
.2 0 – 10 VDC and 4 – 20ma
.3 10K thermistors
.4 1000 ohm Nickel RTD

.2 All output channels shall include diagnostic LED's. Whenever a discrete output has been enabled by the GPEX, an LED associated with that channel shall light. When used with analog output points the LED will indicate the commanded position by dimming and brightening of the LED when the H-O-A is in the Auto position. When the output is commanded to its minimum position the LED will become dim. As the analog output commanded position increases, the brightness of the LED will increase, until it is fully illuminated at the maximum commanded output.

.3 Each input and output channel shall include a configuration switch such that the user shall be able to select the input or output type from any of the types listed above. The GPEX and GPEX-I/O shall not require wiring to a terminal strip. Both types of controllers shall utilize "plug type" terminals such that the user may be able to disconnect and replace a module simply by removing the plug type connectors and plugging them into a new module.

.5 Controller Attributes

.1 The controller shall be powered from standard, off-the-shelf, Class II, 24-volt transformers. The controller shall be listed under UL916-PAZX (Energy Management), VDE, and CSA. Products shall be manufactured in a facility having a Quality System that is registered to either ISO 9002 or ISO 9001 Quality Assurance Standard. The controller shall be designed to be easily mounted in a standard NEMA 1 type enclosure without special rails or mounting hardware and as local and national code dictates.

.2 The controller shall include a 365-day real-time clock and watchdog timer diagnostic indicator provided by an LED. The watchdog timer shall reset upon power on and be resettable by software thereafter. Should the watchdog timer not be resettable during the timing period, it shall time out and set all outputs to their non-powered state. The LED shall illuminate solidly to indicate this failure.

.3 The controller shall not require a battery. All configuration data, custom programs, etc., will be stored in non-volatile memory. The controller shall provide a minimum of two days data retention for the time clock and consumable data (runtimes, GPM, KWH, etc.). Systems that require a battery to store data are not acceptable.

.4 The controller shall include the capability to provide a local interface for all operating values, alarms, etc., via a hand held, panel mounted, or remotely mounted Local Interface Device. The controller shall also be capable of interfacing to a portable PC for configuring or altering the configuration, setting the address, performing uploads/downloads, entering of custom programs, etc., through a separate, additional RJ14 plug.

.5 The controller shall be capable of operating in either a stand-alone mode or as part of a network with an EMS operator's station and other system elements including Product Integrated Controllers (PIC's).

.6 Controller Software

.1 The controller shall provide stand-alone operation and shall accept analog and discrete signals from sensors, switches, relays, etc., and shall multiplex the various signals into digital format. All closed loop Direct Digital Control routines shall utilize controller based software algorithms

that shall be resident in its memory. All standard and custom control controller based algorithms shall operate independently, and systems that require an on-line host computer or intermediary processor to control mechanical or electrical equipment are not acceptable.

.2 Time Schedules:

.1 Each time schedule shall include provisions for eight individual-day types (Monday through Sunday and holidays), and each individual-day type shall contain at least seven individual on-off time periods. The controller shall support one-minute granularity. Systems that use a granularity of greater than one minute shall not be accepted.

.3 Setpoint Schedules:

.1 Each setpoint schedule shall be individually definable in terms of:

.1 Engineering Units
.2 Occupied High Setpoint
.3 Occupied Low Setpoint
.4 Unoccupied High Setpoint
.5 Unoccupied Low Setpoint

.2 Controller software shall include the capability to link specific time schedules with corresponding setpoint schedules for any particular DDC loop.

.4 Remote Timed Override:

.1 The controller shall support remote timed override through the use of a space sensor with an integral override button or a momentary contact switch. Whenever the override is initiated during the unoccupied period and the controller is configured to provide remote override the time schedule associated with the override shall become occupied for 0-1-2-3-4 hours (operator selectable). Whenever the time schedule becomes occupied the controller shall control its associated control points to their occupied setpoint.

.2 The controller shall provide a power-fail restart routine that shall provide an adjustable staggered time delay for each DO point selected, to avoid sudden power peaks.

.7 Input/Output Signal Processing

.1 Input Processing:

.1 Each connected or calculated input point shall be independently processed to provide accurate data values. All point processing shall be performed by the controller. All connected and calculated points, both analog and discrete, shall be individually configured and be capable of displaying their values at the LID, portable PC or at a connected EMS operator's station. Input points may be added, deleted or modified via the Local Interface Device, portable PC, and if tied into a network, by the EMS operator's station. Discrete input points shall be monitored for status, alarm or consumable data.

.2 Analog inputs shall be monitored to provide feedback to a control loop, to annunciate that an analog alarm limit has been exceeded, to offer centralized analog monitoring or to monitor consumable data. Discrete and analog inputs shall be able to interact with controller resident algorithms for local processing.

.3 The operator shall be able to create sensor groups for use in the algorithms. The sensor groups will provide the lowest, highest, or average values, as applicable to the application and algorithm.

.4 Controller software shall include a trim function to allow for the field calibration of analog input sensors.

.2 Alarm Processing:

.1 The controller shall contain a routine to process alarms and alerts. Alarm processing shall be initiated once per second and shall consist of a scan of all input points. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.

.3 Output Processing:

.1 Discrete Outputs:

.1 Discrete outputs shall be used to command two state devices (on/off, open/close, etc.). Each discrete output point must be capable of being individually configured by the operator.

.2 The following types of direct digital control routines shall be provided for discrete outputs as a minimum:

.1 Enthalpy/Analog Comparison
.2 Analog
.3 Interlock
.4 Time Clock/Cycling
.5 Time Clock/Cycling with Temperature Override
.6 Staged Thermostat (Minimum of four stages plus fan)
.7 Staging Control (Minimum of 6 stages. For VAV, CV air handlers with electric heat and/or DX cooling and cooling towers)
.8 Lead/Lag Pump Control with Automatic Fault Logic

.3 Staging algorithms will include adjustable on/off delays as well as adjustable differential between stages.

.4 Analog Outputs:

.1 Analog outputs shall be used to command modulating/variable position devices. Each analog output must be capable of individual configuration via the operator.

.2 As a minimum, the following preprogrammed analog out algorithms shall be resident at the controller:

.1 Cooling Coil Control with Dehumidification (CV and VAV)
.2 Heating Coil Control (CV and VAV)
.3 Mixed Air Damper Control (CV and VAV including Indoor Air Quality Damper Override)
.4 Minimum Outside Air CFM for VAV Air Handlers
.5 Air and Water Reset
.6 Humidification
.7 Sequenced Cooling and Heating Coil Control for CV Applications
.8 Static Pressure and Fan Tracking Control
.9 Adaptable Control

.3 Systems which require a host computer to perform any of the above algorithms shall not be acceptable. The algorithms shall support both dual (master/submaster) and single control loops, and shall include PID control, as required.

.5 Overrides and Interlocks

.1 Provide the capability to manually override a controller's input or output value and input a different value in its place. Manual overrides shall be capable of being initiated via the Local

Interface Device, portable PC or the EMS operator's station, if part of a network. All manually initiated overrides shall be manually removed.

.2 The controller shall also be capable of providing event initiated overrides of normal control algorithms. Specific preprogrammed interlock sequence programming shall be configured via either the Local Interface Device, portable PC or the EMS operator's station, if part of a network.

.6 Stand-Alone Data Collection

.1 Traces:

.1 The controller shall include the inherent ability to perform automatic point tracing based on a change in value of a discrete or analog point. The trace function shall be operator selectable to store up to 60 samples at an operator-configured interval. When the point trace is full the operator shall be able to have the trace stop, wrap around, or to stop and trigger another trace of the point to begin. The trace values shall be displayed at the LID, portable PC or EMS operator's station, if part of a network.

.2 Runtimes/Consumables:

.1 Any discrete input may be linked by the operator to a runtime table for the purposes of displaying equipment runtime totals. Equipment runtime alarms shall also be displayed at the LID.

.2 Any discrete or analog input shall be capable of being used to calculate and display consumable data such as; GPM, KWH, #/hour, etc. This information shall be displayed at the LID.

.7 Custom Programming

.1 Provide a controller based, user-friendly interactive, programming language for the purpose of creating custom programs for specific, unique applications. Complex control strategies shall be able to be developed by the end user.

.2 All custom programming must be performed in English language and shall be addressable by user specific English names without requiring alphanumeric addresses or point numbers. Programming languages such as BASIC or FORTRAN shall not be acceptable for these applications, and the custom programs shall be retained in controller memory and shall not require a host CPU to operate correctly. Custom programs shall be capable of supporting either SI metric or customary US units. All custom programming point data shall be capable of being transferred from one controller to another (if networked) directly without an on-line CPU or host computer.

.8 Communicating Input/Output Module

.1 The communications input/output module shall be a general purpose software storage module that is connected to the Communications Bus. The module shall be capable of the following functions:

.2 Interface between remotely located Energy Management PC and Communications Bus.

.3 Interface between primary and secondary Communications Buses.

.4 Storage of peak demand limiting, data collection and data transfer, Alarm Printer Interface, Chiller Plant Manager, TeLINK, etc.

.9 Communications Bus (When part of a network)

.1 The Communications Bus shall be a three-conductor cable with shield. EIA Standard RS-485 Communications protocol shall be employed and the communications bus shall be capable of having multiple system elements connected. Each Communications Bus shall allow for the use of modules as an interface to secondary Buses. Whenever the Communications Bus enters or leaves a building, the Bus shall be provided with adequate lightning suppression devices.

.2 The Communications Bus shall be capable of communicating through a telephone modem to a remote building. This interface shall allow any Energy Management PC operator's station to communicate with any other remotely located, compatible, Communications Bus.

.10 Field Installed Sensors

.1 Space Temperature Sensors

.1 Space Temperature Sensors shall be thermistor type with wall plate adapter and blank cover assembly. The sensor shall include an integral occupancy override button and shall also include a RJ11 communications port. Space Temperature Sensors shall include space temperature adjustment slides where shown on the plans.

.2 Duct Temperature Sensors

.1 Duct Temperature Sensors shall be 1000 ohm averaging RTD's, or thermistor type.

.3 Water Temperature Sensors

.1 Water Temperature Sensors shall be well mounted thermistor type or 1000 ohm RTD.

.4 Status Indication

.1 Status indication for fans and pumps shall be provided by a current sensing sensor. The unit shall consist of a current transformer, a solid state current sensing circuit (with adjustable set point) and a solid state switch. A red light emitting diode (LED) shall indicate the on off status of the unit.

.5 Low Temperature Detection Thermostat

.1 Low Temperature Detection Thermostat shall be provided to stop each air handling system as indicated and shall be of the manual reset type unless otherwise specified with sensing element not less than 20 feet long. Any one foot of sensing element, when subjected to temperatures below setpoint of controller, shall actuate thermostat switch mechanism regardless of temperature being sensed by the remainder of the element. The device shall have double pole, double throw contacts for fan shut down and remote alarming.

.6 Relative Humidity

.1 Duct and space Relative Humidity Sensors shall have a range of 0-100% RH, and the measuring accuracy shall be 5% over the range. The space sensor shall be provided with wall plate adapter and blank cover.

.8 Controlled Devices

.1 Motorized Control Dampers

.1 Multiple blade dampers shall be parallel or opposed blade type as listed **below or** as scheduled on the drawings. Single blade round dampers shall have an elliptical blade.

.1 Modulating outdoor air and exhaust dampers shall be opposed blade type with blade and side seals.

.2 Modulating return air dampers shall be parallel blade type with blade and side seals.

.3 Two position shut off dampers may be parallel or opposed blade type with blade and side seals.

.2 Damper frames shall be 16 gauge galvanized steel channel or 1/8" extruded aluminum with reinforced corner bracing.

.3 Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (<2000 fpm). Blades shall not be less than 16guage.

.4 Damper shaft bearings shall be as recommended by manufacturer for the application, Oilite or better.

.5 All blade edges and top and bottom of the frames shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 cfm/sq. ft at 4" w.c. differential pressure.

.6 Individual damper sections shall not be larger than 48" wide x 60" high. Provide a minimum of one damper actuator per section.

.7 Dampers shall have exposed linkages.

.2 Electonic Valve And Damper Actuators

.1 Electronic actuators, less than 600 in-lb. of rated torque, shall have ISO Electronic 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification.

.2 Electronic actuators used on valves or dampers shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt, or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.

.3 Actuators shall be fully modulating/proportional, pulse width, floating/tri-state, or two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.

.4 Optional auxiliary switches shall be available.

.5 Actuators shall have an operating range of –22° to 122°F.

.6 Proportional actuators shall accept a 0-10 VDC or 0-20 mA input signal and provide a 2-10 VDC or 4-20 mA (with a load resistor) operating range.

.7 Actuators shall be capable of operating on 24, 120 or 230VAC, or 24VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 50 VA for AC, including 120VAC actuators.

.8 Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation

.9 For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models > 60 in-lbs. will be capable of mounting on shafts up to 1.05" in diameter. Spring return actuators with more than 60 in-lb. of torque shall have a metal, manual override crank.

.10 Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.

.11 Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Valves and dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators.

.12 Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be "off the shelf," standard actuators ready for field wiring.

.13 Damper and valve actuators will not produce more than 62 dB when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dB(A) with power on or in the running or driving mode.

.3 Direct Coupled Globe Valve Actuator And Adaptor Bracket:

.1 Actuator shall be designed with an integrated adaptor bracket that will direct mount to the valve.

.2 Actuator shall provide a linear force capable of fulfilling the required close-off of the valve.

.3 Actuator shall include an automatic valve-coupling device that shall lock securely to the valve stem.

.4 Proportional and spring return actuators shall adapt upon powering the actuator. This adaptation will determine stroke length and enable the actuator to set the minimum and maximum limits of the supplied control signal, thereby utilizing the entire control signal range. Feedback, running time and other parameters are automatically adjusted to the effective stroke.

.5 Actuator shall have a manual override equipped with an inter-locking device to protect the actuator from over-torque of the manual override.

.4 Industrial Type Actuators For Butterfly Valves

.1 The valve actuator shall consist of a capacitor-type reversible electric motor, gear train, limit switches and terminal block, all contained in a die cast aluminum enclosure.

.2 Enclosure shall be designed to meet NEMA 4 (weatherproof) requirements, or CSA approved for non-hazardous or hazardous locations.

.3 Output shaft shall be electroless nickel plated to prevent corrosion.

.4 The enclosure will have an industrial quality coating.

.5 Actuator shall have a motor rated for continuous duty.

.6 Actuator shall be suitable for operation in ambient temperature ranging from -22°F to +150°F [-30°C to +65°C].

.7 The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 pH, 60 Hz

supply. A self-resetting thermal switch shall be imbedded in the motor for overload protection.

.8 A 6 ft wiring harness shall be provided for ease in field wiring (Above 1500 in-lbs).

.9 Actuator will have a suitable sized NPT entry for external connections.

.10 Reduction gearing shall be designed to withstand the actual motor stall torque.

.11 Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.

.12 Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel.

.13 2 SPDT auxiliary switches, rated at 250 VAC shall be included.

.14 Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel, where applicable, must be permanently attached to the actuator.

.15 When in manual operation electrical power to the actuator will be permanently interrupted.

.16 The hand wheel will not rotate while the actuator is electrically driven.

.17 Actuator shall have heater and thermostat to minimize condensation within the actuator housing.

.18 Modulating units shall include programmable card capable of 0-10 VDC, 2-10 VDC, 4-20mA, and 1-5 VDC default settings.

.5 Electronic Control Valves

.1 GENERAL

.1 The manufacturer shall be capable of providing individual valve identification tagging on each printed valve label. Valve tag identification shall be documented on the approved, submitted valve schedule.

.2 Valve actuator(s) shall provide the minimum torque, based on the manufacturers' calculations, required for the rated valve close off.

.2 Zone Valves

.1 Zone valves shall be as specified.

.2 Zone valves with brass bodies shall be used in terminal unit water applications where sizing or physical limitations prohibit the use of characterized control valves, or in terminal equipment, where water sizing dictates a 2 or 3-way electronic control valve 3/4" or smaller.

.3 The valve manufacturer shall provide the contractor a choice of threaded union male NPT, compression ends or copper sweat ends for each valve.

.3 Zone valve actuators shall have a minimum of 30 psi close-off rating.

.6 Control Valves

.1 Control valves shall be of the Characterized Control™ Valve type.

.2 Characterized Control™ Valves shall be used for all water applications where sizing permits.

.3 A TEFZEL, flow-characterizing disc shall be installed in the inlet of 2-way characterized control valves and in the control port of 3-way valves. The valve trim shall utilize a stainless steel ball and

stem for all water or glycol solutions up to 50%. For water applications, an optional chrome plated brass ball and brass stem can be used.

.4 Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1-1/4" shall be rated at 600 psi and sizes 1-1/2" to 2" at 400 psi. The maximum allowable pressure differential shall be 150 psi for on/off and 50 psi for modulating service.

.5 Characterized Control™ Valves shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.

.6 The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.

.7 A non-metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

.7 Globe Valves:

.1 Globe valves shall be as specified.

.2 2-way and 3-way globe valves may be used only if characterized control valves do not fit the sizing criteria or application.

.3 Globe valves may be used for chilled or hot water, steam, or glycol solutions to 50%. Screwed and flanged water valves shall have equal percentage or linear flow characteristics for 2 or 3-way valves, respectively. All stems shall be stainless steel.

.4 Screwed globe valves 1/2" through 2" shall have bronze bodies rated at ANSI Class 250. For water or steam up to 35 psi, trim shall include a brass plug, a spring-loaded TFE packing, and a bronze seat. The maximum differential shall be 35 psi for water and 20 psi for steam.

.5 2-way and 3-way flanged globe valves 2-1/2" to 6" shall have cast iron bodies rated for ANSI Class 125. The maximum differential shall be 25 psi for water and 10 psi for steam. Trim shall include stainless steel stems, bronze plugs, bronze seats, and a TFE V-ring packing.

.6 For steam inlet pressures higher than those stated above, furnish globe valves with stainless steel trim specifically rated for the application.

.8 Butterfly Valves:

.1 Butterfly valves shall be as specified;

.2 Butterfly valves 2 to 12" shall have a fully lugged, drilled and tapped, cast iron body. Flanges shall meet ANSI 125/150 standards. The one-piece body shall feature an extended neck allowing sufficient clearance for flanges and 2" of piping insulation. The disc shall be aluminum bronze and provide bi-directional bubble-tight close off in either direction for water or 50% glycol applications. The disc shall be polished and contoured to minimize torque and wear. The flow characteristic shall be modified equal percentage for 2-way valves and linear for 3-way valves. The 2" - 6" valves shall be rated for a maximum

of 200 psi close-off and 8" - 12" shall be rated a maximum of 75 psi close-off.

.3 The disc shall have full 360-degree concentric seating. A 316 stainless steel taper pin shall provide a positive connection of the disc to a one piece, 416 stainless steel shaft. A phenolic backed, non-collapsing, EPDM seat shall be field replaceable and shall create a positive seal between flange face and valve body. No gaskets shall be required between the valve and flange faces. The shaft shall be supported at three locations by PTFE bushings.

.4 Butterfly valves may be used in all two-position applications, in modulating applications larger than 2-1/2", or where the close off rating of other valve styles does not meet the design requirements.

.5 A CV factor of sixty (60) degrees shall be used for sizing all modulating butterfly valves

.6 High torque industrial valve actuators, >600 in-lb. of rated torque, may be used where low torque actuators are not suitable.

.7 High torque electronic industrial actuator enclosures shall be designed to meet NEMA 4 (weatherproof) requirements, or have CSA approval for non-hazardous or hazardous locations. An NPT entry for external connections shall be provided.

2.3 Software

.1 Operating Software

.1 Multi-tasking, single user operating software shall be provided for the operators station, as shown in the contract documents. The vendor shall provide all required software, including the database. The PC shall be capable of running Either Windows 95 or Windows 98 operating system. All new PC's shall include Windows 98 operating software.

.2 Passwords

.1 The proposed system shall be capable of supporting a minimum of 100 unique operator Energy Management System (EMS) passwords. Each operator shall be assigned an access level for each area defined. A minimum of five pre-defined (View only, Force-Auto, Custom programming, etc.) operator access levels based on an area by area basis and shall also include the inherent capability to permit restrictions of operator access to certain controllers in certain areas.

.3 Operator Interface

.1 The proposed system shall include screens with standard windows format, commands, menu conventions, and dialog boxes. The operator shall have access to a full array of help displays to assist while on-line, including context sensitive one-line help, based on the current cursor position. . The Program Manager shall include a separate group icon for access into the EMS system with additional program item icons.

.2 The operator if allowed by password shall be capable of forcing/autoing EMS points based on a pre-defined schedule

.4 Wizards

.1 The proposed system shall include HELP Wizards to assist an inexperienced operator. Help wizards shall be provided for reports, alarms, Trends, viewspace databoxes and operator profiles, as a minimum.

.5 Alarm Manager

.1 Each alarm shall include the areas name, controller name, bus and element number, the alarm status and priority, time and date of occurrence, point name and explanatory text, plus a custom message. In addition to the alarm custom message, an operator entered/modified note shall be available for viewing, printed with the standard alarm message, or copied to the Windows Clipboard. The alarm note toolbar icon will change its characteristics, such that the operator can easily determine if a note was attached to an alarm. Each alarm shall also include command icons to provide the means of quickly jumping to a Graphic/Plot pertinent to the alarm condition, acknowledging alarms, viewing or appending operator notes, etc. The system shall be provided with the capability of providing a Dynamic Data Exchange (DDE) or equivalent, of alarm information to third party software.

.2 The system shall be capable of storing a minimum of 500 network alarms/alerts in an active buffer before they are automatically archived to disk.

.6 Alarm Notification

.1 The proposed system shall be capable of assigning different alarm notification types. One type shall provide an audible tone or WAV file sound. A second type shall notify the operator by displaying a flashing alarm icon along with the level of the alarm (and audible beep). Another method shall be a pop-up window alarm display on top of the current window (and audible beep). The system shall also provide support for critical alarms. When a critical alarm occurs a full screen alarm pop-up window shall cover the existing window. The operator shall have the capability of running third party software and still receive alarm indication as described above.

.7 Reports

.1 The Energy Management System shall include the inherent ability to store, view and print energy consumption data, runtime data, and trend analog or digital variables. These reports shall also include a summary of consumption and runtimes. Standard management reports shall be provided as well as the capability to provide custom reports. The operating system shall be multi-tasking such that the operator may select other programs to run in the operating system environment without losing report data. Reports shall be generated automatically or manually as selected by the operator. The daily, monthly and yearly consumption report shall collect from either a digital or analog point. The daily, monthly, and yearly runtime report shall allow digital outputs/inputs to be totaled to indicate the total runtime of a piece of equipment. The operator shall be able to reset the runtime total for each input. Trend data shall allow the operator to collect and display events for each digital or analog point. The proposed system shall provide a report panel window with icons for the operator to select from. The operator shall also be able to add an icon to initiate the execution of a custom report from a third party spreadsheet in addition to the supplied standard report icons.

.2 Standard Windows type toolbars and dialog boxes shall be provided to ease the task of report definition. Dialog boxes shall also be provided to ease the task of report formatting and reports shall be displayed as they would be printed via a print preview command. The operator shall have the capability to change any value in the report or to hide any row or column in the report through standard Window type commands.

.3 System Activity Report - The operator shall have the ability to easily create and generate operator activity reports. The report shall have the ability to monitor and log all system operator activities such as; operator login/off, operator forces, modifications to setpoint/time schedules, changes to controllers, areas, etc. DDE POKE commands and DLL interface changes to setpoints or time schedules shall be identified as a third party in the Systems Activity Report.

.8 Graphic/Plot Display Manager

.1 The Graphic/Plot Display Manager (GDM) shall allow the operator the ability to organize and view real time point data from multiple controllers, all on one screen. The proposed system shall be supplied with standard and customized HVAC graphics as required. The graphic package shall provide for multiple link areas, bookmarks, speed buttons and the ability to command point override values through Window Dialog boxes.

.2 The GDM shall be capable of displaying multiple dynamic system graphics with point values, units, names, alarm status, configuration decisions, setpoints, etc., and also multiple point trends, all on one screen. The GDM shall allow the operator the ability to include and display DDE data from other applications. As point data changes the data to the DDE system or equivalent. The GDM shall also be capable of interfacing to third party DDE "POKE" messages. Third party access to setpoints and time schedules shall be via Dynamic Link Library (DLL)

.3 Each Trend shall include the capability for the operator to select pause, start, autostart on and a sampling period.

.4 The GDM shall include standard window menus, tool bars, dialog boxes, drop down lists, etc. The operator shall be able to force or auto point values and watch how the system responds dynamically, all on one screen. The graphics screens shall include the ability to support animated data boxes.

.9 Remote Access

.1 The system shall include the capability to permit remote communications to multiple remote EMS sites through phone modems and vendor specific software. When a remote EMS site is connected to the network, the operation of the EMS computer shall be unaffected. Alarms shall continue to be printed and logged to the database.

.10 Log On/Off

.1 After successfully logging in to the Multi-tasking operating system, the operator shall not be granted access into the EMS system until the selection of the EMS log-in icon is made, and the operator successfully enters the assigned login name and password. When the operator has successfully logged in to the EMS system, an EMS logout icon shall be displayed at the bottom of the screen. The system shall also provide the capability to assign each EMS operator an EMS start-up application (i.e., Alarm Manager, Reports, Network Manager, etc.). After logging on to the system this function shall automatically open up to the function defined on start-up. The system shall include the capability to automatically log out an operator after a user specified inactivity time.

2.4 Global Network Programs

.1 Global network programs shall be modular. Modules shall be added to meet the requirements of the system. The network shall be capable of accepting additional

modules at any time. Each module shall enhance the network operations. The following global network programs shall be available:

.1 TeLINK

2.5 TeLINK

.1 The Autodial Gateway option module/TeLINK shall permit communications from a remote Building Control System to a Energy Management PC to create a window into the remote network. There shall be two types of communications between the BCS network and the remote Energy Management PC:

.2 Telephone calls placed manually by an operator working at the Energy Management PC. Telephone calls shall be placed manually by the operator by selecting the appropriate building from the Energy Management PC's main menu. These shall be made for the purpose of controlling and/or monitoring BCS networks at a remote site or calls placed automatically for the purpose of generating reports.

.3 Telephone calls placed automatically by a BCS Autodial Gateway option module/TeLINK. These shall be made for the purpose of reporting alarms and alerts.

.4 If proposing the Autodial Gateway then use the following Autodial

.1 Gateway portion of this specification and delete the TeLINK section immediately following, and all reference to TeLINK above. If proposing the TeLINK then delete this Autodial Gateway section immediately following, and delete all references to the Autodial Gateway found above.

.2 The Autodial Gateway option module shall provide the following system parameters as a minimum:

.1 Occupied and unoccupied time schedules. Each time schedule shall support eight periods as a minimum

.2 8 occupied and unoccupied alarm phone numbers/passwords

.3 A buffer to store at least 20 alarms

.4 A buffer to store at least 20 alerts

.5 Occupied and unoccupied beeper phone numbers

.6 Building names/numbers

.7 Alarm priority threshold - Determines the lowest alarm priority level that will be transmitted off-network as soon as it occurs. Alarms of lower priority shall be treated as alerts and shall not be transmitted until twenty of them accumulate or a chance presents itself to transmit them on a connection established for another purpose.

.8 Alarm connect time - Determines the number of minutes the connection shall be kept open for reporting alarms.

.9 Inactivity connect time - After an operator defined connect time has elapsed, where there has been no communications between the modems, the connection shall be broken. An alarm message shall be generated when this occurs.

.10 Modem baud rates - The modems shall automatically negotiate the highest common baud rate when establishing communications.

.11 Beeper alarm priority - Determines the alarm threshold priority level associated with dialing to a beeper. Alarms below this level are handled as an alert and are not sent out to the beeper.

.3 The occupied and unoccupied password access routine shall also include a secured mode. If an Autodial Gateway is configured for the secured

mode and it receives an incoming call it shall not allow access when it receives the secured password. Instead it shall command its modem to go off line and dial the telephone number of the Autodial gateway that transmitted the secured password. It shall supply the initiating Autodial Gateway with a call back password and if the password is accepted, access shall be allowed.

.4 The Autodial Gateway option module shall generate an access alert anytime a connection is complete. The access alert shall appear in the alarm file and include the telephone number of the Autodial Gateway Option module that initiated the connection.

.5 All alarms with priority levels below the configured alarm threshold shall be treated as alerts. As alerts occur, the Autodial Gateway Option module shall store them in a buffer that shall hold 20 alerts as a minimum. The occurrence of the twentieth alert shall cause the Autodial Gateway Option module to place a call to a remote Energy Management PC. If a call is initiated by an alarm the alerts shall be transmitted at the same time.

.6 The system shall also provide an access alarm to be generated to indicate when invalid access attempts have occurred.

.5 The TeLINK option shall provide the following system parameters as a minimum:

.1 Occupied and unoccupied time schedules. Each time schedule shall support eight periods as a minimum.

.2 An occupied and unoccupied phone number or beeper number. The occupied and unoccupied phone number shall contain a back-up phone number.

.3 A buffer to store alarms and alerts.

.4 Building name/numbers

.5 Alarm priority threshold - Determines the lowest alarm priority level that will be transmitted off-network as soon as it occurs. Alarms of lower priority shall be treated as alerts and shall not be transmitted until the buffer is full or a chance presents itself to transmit them on a connection established for another purpose.

.6 Inactivity connect time - After an operator defined connect time has elapsed, where there has been no communications between the modems, the connection shall be broken. An alarm message shall be generated when this occurs.

.7 Modem baud rates - The modems shall automatically negotiate the highest common baud rate when establishing communications.

.8 Beeper alarm priority - Determines the alarm threshold priority level associated with dialing to a beeper. Alarms below this level are handled as an alert.

.6 All alarms with priority levels below the operator configured threshold shall be treated as alerts. As alerts occur the TeLINK shall store them in a buffer. When the buffer is full the TeLINK shall place the call to a Remote Energy Management PC. If a call is initiated by an alarm the alerts shall be transmitted at the same time.

3. EXECUTION

3.1 General Requirements

.1 Installation

.1 Install all system components and appurtenances in accordance with the manufacturer's instructions and as shown. Provide all necessary interconnections, services, and adjustments required for a complete

operable system. Install electrical devices, sensor wiring, communication wiring, and conduit in accordance with Division 16.

3.2 Testing

.1 Procedure
.1 Furnish all labor, material, instruments, supplies and services and bear all cost for the accomplishment of the test herein specified. Correct all defects appearing under the test, and repeat the tests until no defects are disclosed; leave the equipment clean and ready to use.

.2 Governing Authorities/Agencies
.1 Perform all tests other than what is specified which may be required by legal authorities or by agencies to whose requirements this work is to conform to.

.3 Miscellaneous
.1 Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no cost to the owner.

3.3 Acceptance Procedure/System Commissioning

.1 The ATC contractor shall submit for review by the engineer a performance and acceptance sign off sheet. The sign off sheet shall show each physical input, output, control loop, and control sequence. Next to each item will be a space for the engineer/owner to initial for acceptance.

.2 Owner Notification
.1 The ATC contractor shall notify the owner in writing that each system is complete and ready for testing.

.3 Owner Demonstration
.1 The ATC & HVAC contractor shall demonstrate each sub-system completely to the owner's satisfaction as part of the base bid.

3.4 Adjustment

.1 Upon completion of the project, the ATC contractor shall:
.1 Completely adjust, ready for use, all thermostats, sensors, DDC panels, control valves, dampers and damper operators, etc. provided under this section.
.2 Load and debug all software and related database provided under this contract.

3.5 Owner's Personnel Training

.1 Submit an outline of the instruction program and instruction manual to the owner for his approval at least (2) weeks prior to the proposed start date of the instruction sessions. The owner will video tape all instructions for the purpose of future training.

.2 Training
.1 Conduct training at the job site for a period of (3) consecutive days, A training day shall be defined as eight (8) hours of instruction, Monday through Friday, including two - 15 minute breaks, and excluding lunch

time. Train three (3) Owner's personnel in the functional operation of the systems installed and the procedures that they will employ for system operation. Augment this training with two (2) additional days of on-the-job training within one year of acceptance of the DDC system. The training days may be non-consecutive, in accordance with a schedule set up by the owner.

.3 Instructions and Material

.1 Provide a qualified instructor to teach owner's personnel on the operation, adjustment, and maintenance of the equipment and system. Orient the training specifically to the system installed. Provide training materials which describe in detail the hardware, software, and operation of the particular DDC system provided, and equipment and materials required for classroom training.

END OF SECTION

1. SEQUENCE OF OPERATION

1.1 General

.1 Refer to motor list for all equipment to be controlled by BMS including alarms and emergency power.

1.2 Heating Water Control

.1 Provide differential pressure switches in each pump discharge to provide on-off indication to BMS.

.2 Provide differential pressure switch in pump circuit indicate alarm. Provide alarm BMS.

.3 Hot Water supply to be inversely reset from OAT, includes hi-limit control and pump start stop control.

.4 The Hot Water Boiler system shall be directly controlled and monitored by an EMS compatible dedicated stand-alone programmable logic General Purpose Electronic Controller (GPEC).

.5 Sequence of Operation during Occupied Hours:

.1 When the time schedule is in the occupied mode, the AO—Reset algorithm will switch the operation from the unoccupied hot water supply temperature setpoint to the occupied hot water supply temperature setpoint.

.2 Hot Water Supply Pump: The DO—Permissive Interlock algorithm will enable the hot water pumps whenever the outside air temperature is less than 60°F (adjustable). When the outside air temperature is above 60°F, the DO—Permissive Interlock algorithm removes the force on the pumps and a time schedule will turn off the pumps. This time schedule is configured to be unoccupied for 24 hours, 7 days a week.

.3 Boiler: When the hot water pump status is true, the AO—Reset algorithm will enable the boiler circ. pump and modulate the boiler gas valve to maintain the calculated hot water supply temperature setpoint. The hot water supply temperature setpoint will be inversely reset based on the outside air temperature. The AO—Reset algorithm has the capability to limit the hot water supply temperature to 180°F and to perform its control based on its PID calculations.

.6 Sequence of Operation during Unoccupied Hours:

.1 When a time schedule indicates that the system is in an unoccupied mode, the AO—Reset algorithm will switch the operation from the occupied hot water supply temperature setpoint to the unoccupied hot water supply temperature setpoint. This lower setpoint will be inversely reset based on the outside air temperature. All other operations will be the same as during occupied hours.

.7 Sensor Selection:

.1 The sensors required for this application are described below.

.2 OAT – Outside Air Temperature:

.1 An OAT sensor or an OAT reading from another controller will be used by the AO—Reset algorithm to reset the hot water supply temperature based on the outside air temperature.

.3 PMPS – Hot Water Pump Status:

.1 The status of the hot water pumps is required. A current type sensor is required.

.4 HWS – Hot Water Supply Temperature:

.1 A HWS well type sensor is required.

.8 Provide thru BMS:

.1 System graphic
.2 System supply temperature
.3 System supply control point adjustment
.4 System return temperature
.5 Outdoor air temperature
.6 Pump on-off switch
.7 Pump on-off indication
.8 Boilers lead-lag switch

1.3 Cabinet and Unit Heaters

.1 Line voltage thermostats shall cycle unit motor. Aquastat on return heating water line from flow mounted cabinet heaters shall stop unit on low temperature.

1.4 Fan Coil Units \ Radiation

.1 Manual Fan Operation:

.1 When the fan speed/mode selector switch is placed in the "AUTO" position and the controller is in the occupied mode, the controller shall start the fan on "LO" speed and then transition to and from the other speeds based on the Fan Coil Retrofit Controller (FRC) algorithms. When the fan speed/mode selector switch is placed in the "OFF" position the FRC shall disable the fan. When the fan speed/mode switch is indexed to "LO," "MED," or "HI," the FRC shall disable its fan speed control algorithms and operate the fan at the specified speed.

.2 Temperature Compensated Start:

.1 During the unoccupied mode, the FRC shall calculate an optimum start time based on the deviation from setpoint, actual occupancy time, present time, and an operator adjustable recovery rate entered in min./°F.

.3 Occupied Heating Mode:

.1 During the heating mode, the fan shall be run at the lowest speed to maintain air circulation and the perimeter radiation valve will modulate to meet the space load conditions and minimize fan noise. When the unit is unoccupied and is indexed to the occupied mode, the fan shall be started on low speed. The heating valve shall be modulated open to maintain its heating setpoint. As the load increases the valve shall fully open. As the load continues to increase the FRC shall increase the fan speeds. When the load decreases the fan shall be indexed to low speed first before modulating the valve closed.

.4 Occupied Cooling Mode:

.1 During the cooling mode the fan shall be run at the lowest speed necessary to meet the space load conditions and minimize fan noise. When the unit is unoccupied and is indexed to the occupied mode, the fan shall be started on low speed and the

valve shall be modulated to maintain its cooling setpoint. If the load continues to increase, the valve shall be fully open. If the load continues to increase the FRC shall increase the fan speed. As the load decreases the fan speeds shall be reduced prior to closing the valve. If the load continues to drop and the fan speed is operating at low speed, the valve shall modulate closed to maintain its cooling setpoint.

.5 Unoccupied Heating Mode:

.1 When the space temperature falls below the unoccupied heating setpoint the fan shall start and the valve shall modulate open to maintain the unoccupied heating setpoint. If the load continues to increase the valve shall be fully opened before increasing the fan speeds to maintain the unoccupied heating setpoint. As the load decreases the fan speed shall be reduced, at which point the FRC shall begin to modulate the valve closed to maintain the unoccupied heating setpoint. When the space temperature is above the unoccupied heating setpoint, the fan shall be de-energized.

.6 Unoccupied Cooling Mode :

.1 When the space temperature rises above the unoccupied cooling setpoint the fan shall be started and the valve shall be modulated to maintain the unoccupied cooling setpoint. If the load continues to increase the valve shall be fully open before increasing the fan speeds to maintain the unoccupied cooling setpoint. As the load decreases the fan speeds shall be reduced, at which point the FRC shall begin to modulate the cooling valve closed to maintain the unoccupied cooling setpoint. When the space temperature is below the unoccupied cooling setpoint the fan shall be de-energized.

.7 Unoccupied Timed Override:

.1 Timed override shall be used to extend the occupied schedule for zero to four hours. Timed override shall be initiated by the operator or by an occupant pushing the override button on the space sensor, if enabled by the operator.

.8 Linkage Thermostat Operation (Optional System Pilot Thermostat Only):

.1 When the unit is used with the optional Linkage Thermostat, local programming capability for occupied and unoccupied setpoint and local programming capability for both occupancy and holiday schedules shall be provided. Also tenant overrides, control of multiple units (up to 8) from a single thermostat, and a temperature compensated start feature shall also be provided. The thermostat shall provide an LCD for a digital display of the space temperature, current heating and cooling setpoints and time. The unit's operating mode and the supply air temperature shall also be displayed.

.2 The thermostat shall also provide a single common network schedule for any number of units, broadcast time and holidays. It shall also broadcast the value of a point, common to the entire system, such as the changeover status on two-pipe applications.

.3 The temperature compensated start feature shall be provided when the Linkage Thermostat is used. The thermostat and unit(s) shall exchange data through network communications. In this mode, the unit's occupancy schedule shall be determined by the thermostat. If currently unoccupied, the unit's control shall determine if the current space temperature is above the occupied cooling setpoint or below the occupied heating setpoint. If it is,

the unit shall calculate the appropriate biased start time required to achieve the desired setpoints at the scheduled occupancy time. This value shall then be used by the thermostat to determine the start of the next biased occupied period. When the biased occupied period is reached, the unit(s) shall control to the desired occupied heating or occupied cooling setpoint as required.

.9 Tenant Override (Thermostat):

.1 Whenever either setpoint button is depressed on the Thermostat during an unoccupied period, the tenant override mode shall be initiated. If the mode is initiated from the Linkage Thermostat, the duration of the override shall be determined by the value programmed at the thermostat. The override shall also be cleared at the thermostat if desired.

.2 During the override period, the unit's fan shall operate (if configured for continuous operation during occupied) and the unit shall operate as described by the occupied modes.

.3 Controller Retro-fit CV AHU, Application Specific

1.5 Ventilation Units – MUA-6, MUA-7, MUA-8

.1 Unit to run on BMS Schedule (continuously). Provide status to BMS.

.2 Modulate gas valve and 2-way cooling control valve to maintain discharge air temperature, reset by BMS.

.3 Provide low limit alarm to BMS.

.4 Heating to be locked out when cooling is called. Cooling to be locked out when heating is called.

1.6 Parking Ventilation System – MUA- 1 to MUA-4, and EF-1 to EF-4

.1 The make-up air and exhaust fans shall be started on a signal from any one or more carbon-monoxide detectors on that respective level.

.2 There shall be a time delay to prevent short cycling of the fan.

.3 The fan can also be started according to a DDC time program.

1.7 Stairwell Pressurization – MUA-5

.1 Unit to be activated on call from fire alarm system.

.2 Modulate gas valve to maintain discharge air temperature.

1.8 Chilled Water System Chillers, Chilled Water Pumps

.1 Chiller shall be independently controlled through a manufacturer supplied, local control panel.

.2 Chiller and associated pumps, and fan coil pumps, are enabled at -20°C ambient temperature through DDC panel.

.3 Chilled water pump shall start on signal from DDC panel according to demand.

.4 When chilled water flow is proven by a flow switch and the chilled water pump is activated, the chiller shall be enabled.

.5 All necessary field wiring shall be by the Controls Contractor.

.6 Chilled water temperature shall be reset from DDC control panel.

.7 Maximum chiller load shall be limited by a signal from the DDC panel.

.8 Provide thru BMS:
- .1 System graphic
- .2 Chilled water pump on-off auto switch
- .3 Chilled water pump on-off indication
- .4 Chiller on-of (auto) switch
- .5 Chiller on-off indication
- .6 Chilled water supply temperature
- .7 Chilled water control point adjustment

1.9 Excess Pressure Control

.1 Open modulating bypass valve from controller sensing pressure differential between supply and return lines.

1.10 Emergency Generator Ventilation

.1 On temperature rise, thermostat shall modulate outside and exhaust dampers open, and recirculation dampers closed.

.2 Provide solenoid valve to positively shut off supply when generator is not operating.

.3 On temperature fall, thermostat shall cycle unit heater fan.

1.11 Domestic Hot Water Tank & Recirculating Pump

.1 Tank temperature will be controlled by manufacturer supplied, pre-wired controls.

.2 Domestic water supply temperature to be indicated at DDC panel.

.3 Recirculating pump will be cycled through DDC panel to maintain recirculating temperature and according to DDC time schedule.

1.12 Storm and Sanitary Pump Hi-Level Alarm

.1 Hi-level float switches in each sump shall be wired to the DDC panel.

1.13 Suite Washroom Exhaust Fans

.1 Controlled by wall switch.

1.14 Exhaust Fans - EF-5 to EF-9, EF-11

.1 Fans to run on BMS schedule.

1.15 Electrical Rooms and Telephone Rooms

.1 On rise in space temperature open two-position dampers and activate exhaust fan.

1.16 Miscellaneous Transfer Fans – TF-1 to TF-23

.1 To run on BMS schedule.

END OF SECTION

1. GENERAL

.1 Provide complete gas detection system for the parking garage level(s). System shall provide continuous monitoring of carbon monoxide levels in parts per million (PPM). A signal from gas detection unit shall be used to start and control exhaust fans. Sequential or spot monitoring will not be acceptable. All sensors shall be factory calibrated before on-site installation.

.2 Manufacturer's technician shall be on-site during system start-up. System shall be suitable for operation at temperature of -30°C to +30°C and relative humidity to 100%. Locate sensor(s) as shown on drawings or as described herein.

.3 Power wiring (120/1/60) from electrical panel to unit control panel shall be provided by Electrical Division 16. Provisions for all other wiring shall be provided by Mechanical Division 15, as follows.

- .1 Low voltage (2-#18 A.W.G.) shielded wires form unit panel to exhaust fan(s).

.4 Unit control panel to include the following features:

- .1 LED indicators for: Power On, Low Level Alarm, High Level Alarm, Auxiliary Relay Active, and Sensor Fail. Sensor fail light to indicate "out of calibration" and/or wire disconnected.
- .2 Switches on front panel for: Power on/off, audible alarm disable, test switch that activates LED indication and relays, reset switch for manual reset of latched relays.
- .3 Time delay relays, all relays may have immediate or delay action (30 second intervals to two hours and two minutes intervals to 8 hours).
- .4 User adjustments on front panel for relay for relay trip points.
- .5 Solid state circuitry.
- .6 Necessary logic circuit to activate the appropriate fan(s).

.5 System shall carry a two year manufacturer's warranty.

.6 Sequence of Operation

- .1 Low level alarm condition to activate exhaust fans and interlocked make-up air units at 50 ppm with visual indication on unit. Fans shall automatically shut down when low level condition is satisfied.
- .2 High level alarm condition to activate visual and audible alarm at 100 ppm, should condition remain for more than ten minutes (refer to 1.4.1). High alarm shall automatically reset when high level condition is satisfied.
- .3 Should system fail to operate properly, fans shall be automatically activated until repairs are made.

.7 Provide multiple point system as manufactured by Q.E.L.

END OF SECTION

1. GENERAL

.1 Provide complete refrigerant gas detection system for the mechanical chiller room(s). A signal from gas detection unit shall be used to start exhaust fans and shut off all gas fired appliances in room. All sensors shall be factory calibrated before on-site installation.

.2 Manufacturer's technician shall be on-site during system start-up. System shall be suitable for operation at temperature of 0°C to +40°C and relative humidity to 95%.

.3 All low voltage power and control wiring shall be provided by Mechanical Division 15.

.4 System to include the following:
- .1 Expansion module specified.
- .2 Refrigerant gas detectors (R410A).
- .3 Flashing light-horn silence key.
- .4 Manual fan override.
- .5 Break glass switch.

.5 System shall carry a one year manufacturer's warranty.

.6 Sequence of Operation
- .1 Alarm condition to activate exhaust fan(s). Fans shall automatically shut down when low level condition is satisfied.
- .2 Interlock to modulating draft system on gas fired appliances will shut down the appliances

.7 Model shall be VA301EM system as manufactured by Vulcain Inc.

END OF SECTION