Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Bid Opportunity and Specifications shall apply to and form an integral part of this section.

1.2 SCOPE OF WORK

.1 Work to include all labour, Material and equipment required for installing, testing and placing in initial operation the following systems as detailed in Specifications of each section and as shown on Drawings.

- .1 Section 15051 Acceptable Materials & Equipment
- .2 Section 15180 Insulation
- .3 Section 15400 Plumbing
- .4 Section 15600 Liquid Heat Transfer
- .5 Section 15800 Air Distribution
- .6 Section 15900 Controls/Instrumentation
- .7 Section 15990 Testing, Adjusting and Balancing

.2 All Mechanical Work to be bid as a single complete Sub-Contract even though Work of various mechanical trades has been further sub-divided into each Section noted above.

1.3 EXISTING CONDITIONS

.1 Examine Site, existing adjacent buildings and local conditions affecting Work under this Contract. Examine Structural, Mechanical and Electrical and all other Contract Drawings to ensure Work can be performed without changes to the building as shown on plans. No allowance will be made later for necessary changes, unless notification of interferences have been brought to Contract Adminstrator's attention, in writing, prior to closing of Bid Opportunity.

1.4 REGULATIONS

.1 Comply with, most stringent requirements of Manitoba Building Code, National Building Code and local regulations and by-laws, with specified standards and codes and this Specification. Before any Work is proceeded with, approved layouts to be filed with and approved by proper authorities.

.2 Provide necessary notices, obtain permits and pay all fees, in order that Work specified may be carried out. Charges and alterations required by authorized inspector of any authority having jurisdiction, to be carried out without charge or expense to The City. Pay all charges for service connections to municipal mains.

.3 Furnish certificates confirming Work installed conforms to requirements of authorities having jurisdiction.

1.5 LIABILITY

.1 Install Work in advance of concrete pouring or similar Work. Provide and set pipe sleeves as required.

.2 Install concealed pipes and ducts neatly, close to building structure so furring is minimum size. Pipes, ducts and equipment installed improperly, to be removed and replaced without cost to The City.

.3 Protect and maintain Work until building has been completed and accepted. Protect Work against damage during installation. Cover with tarpaulins if necessary. Repair all damage to floor and wall surfaces resulting from carrying out of Work, without expense to The City.

.4 During welding or soldering ensure structure is protected against fire, shield with fire-rated sheets and galvanized iron sheets. Mount portable fire extinguishers in welding or soldering areas.

.5 Co-ordinate Work with other sections to avoid conflict and to ensure proper installation of all equipment. Review all Contract Drawings.

.6 On completion of Work, remove tools, surplus and waste Material and leave Work in clean, perfect condition.

1.6 GUARANTEE

.1 Guarantee satisfactory operation of all Work and apparatus installed under this Contract. Replace, at no expense to The City, all items which fail or prove defective within a period of one year after final acceptance of complete Contract by The City, always provided such failure is not due to improper usage by The City. Make good all damage to building incurred as a result of failure or repair of mechanical Work.

.2 No certification given, payment made, partial or entire use of equipment by The City, shall be construed as acceptance of defective Work or acceptance of improper Materials. Make good at once, without cost to the The City all such defective Work or Materials and consequence resulting therefrom, within one year of final acceptance date.

.3 This general guarantee shall not act as a waiver for any specified guarantee and/or warranty of greater length of time noted elsewhere in these documents.

1.7 ENGINEERING OBSERVATIONS

.1 Contractor's Work will be observed periodically by The City, and/or Contract Adminstrator or their representatives, solely for purpose of determining general quality of Work, and not for any other purpose. Guidance will be offered to Contractor in interpretation of plans and Specifications to assist him to carry out Work. Observations and directives given to Contractor does not relieve Contractor and his agents, servants and employees of their responsibility to erect and install Work in all its parts in a safe and Workmanlike manner, and in accordance with plans and Specifications, nor impose upon The City, and/or Contract Adminstrator or their representatives, any responsibility to supervise or oversee erection or installation of any Work.

1.8 WELDING REGULATIONS

.1 Do not weld when temp. of base metal is lower than -17 deg. C except with consent of Contract Adminstrator. At temp. below 0 deg. C, surface of all areas within 75mm (3") of point where weld is to be started to be heated to temp. at least warm to hand before welding is commenced. At all temperatures below +4 deg. C, operator and Work to be protected against direct effect of wind and snow.

.2 Welding shall be performed by welder holding current welder's certificate from Provincial Department of Labour.

.3 Comply with CSA W117.2 "Safety in Welding, Cutting, and Allied Processes".

1.9 MECHANICAL SHOP DRAWINGS

.1 Submit for review a minimum of six sets of detailed Shop Drawings. Refer to Section 15051 "Acceptable Materials & Equipment" for Shop Drawings requirements.

.2 Check Shop Drawings for conformity to plans and Specifications before submission.

.3 Each Drawing to bear a signed stamp including project name and Contractor's Firm name verifying Drawings have been checked prior to submission to Contract Adminstrator. Signature of stamp shall signify the Contractor has checked and found all dimensions to be compatible with the Contract Drawings and all capacities, quantities, sizes and other data contained in the Contract documents have been listed by the supplier on the Drawings and have been checked by the undersigned and found correct.

.4 Clearly show division of responsibility. No item, equipment or description of Work shall be indicated to be supplied or Work to be done "By Other's or By Purchaser". Any item, equipment or description of Work shown on Shop Drawings shall form part of Contract, unless specifically noted to contrary.

.5 Take full responsibility for securing and verifying field dimensions. In case where fabrication must proceed prior to field dimensions being available, check all Shop Drawings and approve for dimensions only. In this case guarantee that dimensions will be Worked to and ensure that other Sub-contractors are aware of these dimensions and shall comply to them.

.6 Review by Contract Adminstrator shall be mutually understood to refer to general design only. If errors in detailed dimensions or interference with Work are noticed, attention of Contractor will be called to such errors of interferences, but Contract Adminstrator's review of Drawings will not in any way relieve Contractor from responsibility for said errors or interferences, or from necessity of furnishing such Work, and Materials as may be required for completion of Work as called for in Contract documents.

1.10 SCHEDULING OF WORK

.1 Building will be occupied 24 hours a day during term of this Contract. In general, Work on the new areas to be performed during normal hours. Schedule new Work so normal functions within building are not interrupted. . Work in remainder of building to be scheduled so as to provide minimum of inconvenience to The Citys. i.e. Perform Work either where areas are vacated during night period or at periods when it is permissible to Work in the existing areas to be approved by The City. Suitable periods for shutting off mechanical services to be arranged with The City's appointed representative. Perform Work requiring shutdown of air systems during night period or on weekends.

1.11 DRAWINGS

.1 Drawings are diagrammatic only and do not show all details. Information involving accurate measurements of building to be taken at building. Make, without additional expense to The City, all necessary changes or additions to runs to accomodate structural conditions. Locations of pipes, ducts and other equipment to be altered without charge to The City, provided change is made before installation and does not necessitate additional Materials and that all such changes are ratified by Contract Adminstrator, recorded on Record Set of Drawings.

.2 Drawings and Specifications to be considered as an integral part of Contract Documents. Neither Drawings nor Specifications to be used alone. Misinterpretation of requirements of plans or Specifications shall not relieve Contractor of responsibility of properly completing Work to approval of Contract Adminstrator.

.3 As Work progresses and before installing piping, ductwork, fixtures and equipment interfering with interior treatment and use of building, consult Contract Adminstrator for comments. This applies to all levels and proper grading of piping. If Contractor fails to perform above checking and fails to inform Contract Adminstrator of such interference, Contractor to bear all subsequent expense to make good the installation.

.4 Drawings indicate general location and route to be followed by pipes and ducts. Where required pipes and/or ducts are not shown on plans or only shown diagrammatically, install in such a way as to conserve head room and interfere as little as possible with free use or space through which they pass.

.5 Refer to Structural Drawings for roof construction details. These shall relate to roof supports, piping penetrating roofs, etc. as indicated on mechanical detail sheets.

1.12 MATERIALS

.1 Materials and equipment specified and acceptable manufacturers are named in this Specification for the purpose of establishing the standard of Materials and Workmanship to which Contractor shall adhere. Bid Opportunity price shall be based on the use of Materials and equipment as specified.

.2

.1 Materials of same general type to be of same manufacture (e.g. all air supply units shall be of same manufacturer). Contractor to ensure that all Sub-contractors provide products of same manufacturer.

.1 Follow manufacturer's recommendations for safety, adequate access for inspection, maintenance and repairs of individual equipment installed.

.2 Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems and without interference with building structure or other equipment.

.3 Provide accessible lubricating means for bearings, including permanent lubricated 'Lifetime' bearings.

.3 Equipment and Materials shown on Drawings and not specified herein, or specified herein and not shown on Drawings, shall be included in this Contract as though both shown and specified.

1.13 ELECTRIC MOTORS, STARTERS AND WIRING

.1 Provide electric motors for all equipment supplied in this Division. Motors to operate at 29 r/S (1800 rpm), unless noted otherwise. Motor design shall comply with Canadian Electrical Code requirements. All electric motors supplied shall be capable of being serviced locally.

.2 All three phase motors shall have a service factor of 1.15 times nominal rated horsepower of the motor.

.3 Operating voltages: to CAN3-C235-83, motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.4 Motors controlled by variable frequency drives (VFDs) shall comply with requirements of CSA Specification C22.2 No. 100-95, Clause 12.4 and shall be permanently marked with the following in addition to the normal marking requirements:

.1 Machine Application (Inverter Duty);

.2 Speed range over which the machine is designed to operate;

.3 Type of torque application for which the machine is designed (e.g. VT (variable torque), CT (constant torque), Chp (constant horsepower);

.4 Type(s) of inverter(s) with which the machine is intended to be used [e.g.: VSI or VVI (6-step voltage source), CSI (6-step current source), VPWM (voltage-source pulse width modulated), LCI (load commutated), cyclonverter].

.5 Motors 0.75 kW (1 hp) and larger shall be high efficiency motors as defined in CSA C390 or IEEE 112B Nominal Standards. Minimum efficiency (%) shall be per the following table.

	Minimum efficiency (%)			
kW	3600 RPM	1800 RPM	1200 RPM	900 RPM
.75	79.0	82.4	81.1	74.4
1.11	81.0	82.8	83.8	76.8
1.50	81.7	83.8	84.4	83.8
2.24	84.6	86.1	86.4	83.6
3.73	86.4	86.9	87.2	85.4
5.60	87.4	88.4	88.2	86.2
7.46	88.4	89.4	88.6	88.6
11.19	89.3	90.1	89.0	88.0
14.92	89.7	90.9	89.8	89.8
18.65	90.0	91.1	90.9	89.6
22.38	90.6	91.5	91.1	90.3
29.84	91.0	92.0	91.6	90.1

List information on Shop Drawing submittals

.6 Determine from electrical Drawings and Specifications, voltage characteristics applying to each individual motor. Where motor voltages are mentioned in this Specification, confirmation to be made by reference to electrical Drawings and Specifications ordering motors.

.7 Division 16 - Electrical to provide starters for all motors, except as otherwise noted. Division 16 - Electrical shall wire from starters to motors.

.8 Wiring required between starters and switching apparatus such as wiring from starters to float switches, pressure switches and all control wiring to be by Division 16 - Electrical except as noted otherwise on Drawings and in Specifications. Provide proper terminal connections and lead wires at motors and other apparatus ready for connection by Division 16 - Electrical. Provide Division 16 - Electrical with accurate locations of electrical connection points and all necessary schematic and other Drawings to facilitate electric Work.

.9 Wiring required under Section 15900 to be performed by Section 15900 except as noted otherwise. Refer also to Section 15900 for further requirements.

.10

.1 Division 16 - Electrical to perform all wiring and make final connections to all controls for chiller, cooling tower and all mechanical equipment where controls are supplied with equipment.

.2 Division 15 shall provide wiring diagrams indicating all power and control wiring requirements.

.11 Division 15 shall provide wiring diagrams indicating all power and control wiring requirements for equipment supplied by Division 15.

1.14 IDENTIFICATION OF VALVES

.1 Provide engraved lamacoid color coded tags secured to items with non-ferrous chains or "S" hooks. Use for valves and operating controllers of all systems. Consecutively number valves in each piping system i.e. domestic water, steam, etc.

.2 For each building, provide tag schedule, designating number, service, function, colour code, and location of each tagged item.

.3 Provide one plastic laminated copy and secure to mechanical room wall where instructed. Place one copy in each maintenance instruction manual.

.4 Identify controls and gauges by labels of 3mm (1/8") plastic engraving stock with white lettering on black background. Size approximately 62mm x 25mm (2-1/2" x 1") high.

1.15 HANGERS AND SUPPORTS

.1 General
- .1 Piping, ductwork and equipment shall be securely supported from building structure. Perforated strap or wire hangers are not permitted.
- .2 Support components shall conform to Manufacturers Standardization Society Specification SP-38.

.2 Installation - Horizontal
- .1 Hangers shall adequately support piping system. Locate hangers near or at changes in piping direction and concentrated loads. Provide vertical adjustment to maintain pitch required for proper drainage. Allow for piping expansion and Contraction. Piping weight and stresses shall be supported independently of any equipment.
- .2 Maximum spacing between pipe supports:
  - .1 Steel Pipe:
    - .1 Up to 50mm (2") diam. - 2.4m (8 ft.)
    - .2 62mm (2-1/2") and larger - 3.6m (12 ft.)
  - .2 Copper Tubing (Hard):
    - .1 Up to 25mm (1") diam. - 1.8m (6 ft.)
    - .2 32mm and larger - 2.4m (8 ft.)
  - .3 Plastic Pipe As recommended by manufacturer.

.3 Installation - Vertical Piping
- .1 Support vertical pipes at each floor by Grinnell Fig. 261 riser clamps. Locate clamps immediately below coupling if possible. Support soil pipe at hub. Brace risers up to 50mm (2") size at intervals not over 2.13m (7'). Support base in approved manner.

.4 Structural Attachments
- .1 To Concrete:
  - .1 Place inserts in structural floors for support of piping and equipment prior to pouring of concrete. Inserts in concrete slabs shall be Grinnell Fig. 285 Light Weight Concrete Insert for loads up to 182 Kg (400#) or

Grinnell Fig. 281 Wedge type concrete insert for loads up to 544 Kg (1200#).

.2 Support hangers in corrugated steel deck by 50mm (2") piece of 3mm (1/8") thick steel plate placed across top of steel deck, secured to hanger rod by washer and nut; prior to pouring of concrete topping.

.3 Where inserts must be placed in existing concrete use Hilti H.D.I. steel anchors as recommended by manufacturer, or if heavy weights must be supported, drill hole through slab and provide 50mm x 50mm (2" x 2") washer and nut above rough slab before floor finish is poured.

.2 To Steel Beams:

.1 Where pipe size is 50mm (2") or less, use Grinnell Fig. 87 Malleable Iron C-Clamp and Retaining Clip, or equal in accordance with B6.

.2 Where pipe size is over 50mm (2"), use Grinnell Fig. 229 Malleable Beam Clamp or Fig. 228 Forged Steel Beam Clamp.

.3 Miscellaneous:

.1 Provide suitable attachments equal in quality to above where required.

.5 Hangers and Supports

.1 Steel Pipe: Up to 50mm (2") - Grinnell Fig. 65 light clevis - size to suit O.D. of pipe. 62mm (2-1/2") and larger - Fig. 260 clevis - size to suit O.D. of insulation.

.2 Copper Tubing (Hard):

.1 Up to 50mm (2") - Grinnell CT65 copper plated clevis - size to suit O.D. of pipe. Fig. 65 may be used if isolation is provided - see below.

.2 62mm (2-1/2") and larger - Fig. 260 clevis - size to suit O.D. of insulation - on uninsulated pipe provide isolation as specified below.

.3 Plastic and Other Types of Piping: Support as recommended by manufacturer.

.4 Provide fabricated steel supports as detailed on Drawings or as required to adequately support piping and equipment. Details to be approved by Contract Adminstrator. Supports shall be of welded construction except where adjustment is required.

.5 Where thermal expansion in excess of 12mm (1/2") axially is anticipated, or where indicated, use Grinnell Fig. 171 Adjustable Pipe Roll or Grinnell Fig. 271 Pipe Roll Stand.

.6 For vertical piping support, use Grinnell Fig. 261 clamp. For vertical copper piping, use Fig. CT-121-C.

.7 Above indicates general requirements. Provide hangers and supports of equal quality to suit job requirements where not covered by the above.

.8 Support groups of horizontal pipes by angle iron trapeze hangers.

.9 Rollers and chairs shall not be installed on trapeze hangers.

.10 Several individual hanger rods may be supported from a trapeze or individual inserts in concrete slab.

.11 Hangers to be adjustable after pipe is in place. Parts must be of adequate strength for weight to be supported with safety factor of 5 to 1.

.12 Hanger Rod:

.1 Support hangers with mild steel rod. Load on hanger not to exceed capacity indicated in following table:

.2 Rod Diam. Max. Safe Load

.1 9.5mm(3/8") 277 Kg(610 lbs.)

.2 13mm(1/2") 514 Kg(1130 lbs.)

.3 16mm(5/8") 822 Kg(1818 lbs.)

.4 19mm(3/4") 1232 Kg(2710 lbs.)

.3 Rods to have sufficient threaded length to allow for vertical adjustment after pipe is in place. Use two nuts in each rod, one above clevis or angle iron, and one below.

.6 Isolation

.1 Copper piping shall be isolated from steel supports by copper plated hangers, plastic coated hangers, tinning pipe at supports, or provision of suitable lead or copper isolators. Where no pipe movement or abrasion is expected, suitable plastic electricians tape may be wrapped around pipe at hangers.

.7 Protection Saddles

.1 On piping 50mm (2") and smaller, carry insulation over pipe hangers. Canvas jacket shall be neatly cut and formed to fit over hangers. On chilled and cold water piping, insert sections of insulation into space above pipe at each hanger. Seal saddle and pipe with insulation.

.2 On insulated steel pipe over 50mm (2") diam. use at each hanger or support, Grinnell Fig. 160, 161 or 162 to suit pipe size and insulation thickness. Pack space between saddle and pipe with insulation.

.3 On copper piping over 50mm (2") diam. use at each hanger or support Grinnell Fig. 167 protection shield or equal in accordance with B6. Shields shall have minimum length of 300mm (12") to spread weight.

1.16 ACCESS DOORS

.1 Division 15 - Mechanical Subcontractor and his Sub-contractors to provide access doors where valves, dampers and/or any other mechanical equipment requiring access are built-in.

.2 In general terms, mechanical Sub-contractor responsible for supplying the valve, dampers etc. shall provide the access door required to get to the valve, damper etc.

.3 Access door to be 2.5mm (12 ga.) steel, 300mm x 450mm (12" x 18"), finished prime coat only, with concealed hinges, anchor straps, plaster lock and without screws, all equal to Milcor manufacture. Where it is necessary for persons to enter through door, doors to be at least 450mm x 600mm (18" x 24").

.4 Supply access doors for concealed valves or groups of valves, dampers, fire dampers, flush valves, shock arrestors, trap seal primers, etc.

.5 Access doors located in fire rated ceilings and walls shall be an approved ULC stamped, fire rated door.

1.17 IDENTIFICATION OF EQUIPMENT

.1 Provide manufacturer's nameplate on each piece of equipment.

.2 In addition Mechanical Contractor shall provide equipment I.D. tag minimum size 87mm x 32mm x 2.3mm (3-1/2" x 1-1/2" x 3/32") nominal thickness laminated phenolic plastic with black face and white centre. Engraved 6mm (1/4") high lettering. For motors and controls and for larger equipment such as chillers, tanks, 25mm (1") high lettering; for hot equipment such as boilers and convertors, provide engraved brass or bronze plates with black paint filled identification.

.3 Identify as follows: equipment type and number (e.g. Pump P-2), service or areas or zone building served (e.g. South Zone Chilled Water Primary).

.4 Provide manufacturers' registration plates (e.g. pressure vessel, Underwriters' Laboratories and CSA approval plates) as required by respective agency and as specified.

1.18 FLOOR PLATES AND SLEEVES

.1 Set sleeves in concrete forms for all pipes and ducts passing through concrete walls, beams and slabs.

.2 Pipe sleeves to extend above floor line as follows:
- .1 Unfinished areas - 25mm (1")
- .2 Finished areas (copper sleeves) - 6mm (1/4")
- .3 Mechanical rooms, kitchens and washrooms - 100mm (4")
- .4 Caulk sleeves to provide watertight installation.

.3 Where pipes pass through floors and walls in finished areas and where exposed to view, provide Crane #10 B.C. chrome-plated pressed floor plates.

.4 Install galv. oversize pipe sleeves on passing through walls or partitions, for building into wall construction, by other trades.

.5 Sleeves and holes for cold water, chilled water and ice water lines to be large enough to accommodate pipe insulation. Insulation on hot water lines may stop at walls or floors.

.6 Prior to installing sleeves in concrete beams, receive final jobsite approval by the Structural Contract Adminstrator.

1.19 MECHANICAL EQUIPMENT GUARDS

.1 Meet safety requirements of Provincial Department of Labour and local authorities having jurisdiction.

.2 Guards for drives shall have:
- .1 No. 2.5mm (12 US std. ga.) galv. 18mm (3/4") mesh wire screen welded to steel angle frame.
- .2 No. 1.2mm (18 US std. ga.) galv. sheet metal tops and bottoms.
- .3 Removable sides for servicing.

.3 For flexible couplings, provide removable,'U' shaped, 2.5mm (12 ga.) galv. frame and 1.2mm (18 ga.) expanded mesh face.

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

.5 Install belt guards to permit movement of motors for adjusting belt tension.

.6 Provide 18mm (3/4") mesh wire screen on inlet or outlet of exposed fan blades.

.7 Provide 37mm (1-1/2") diameter hole on shaft centre for insertion of tachometer.

1.20 V-BELT DRIVES

.1 Fit reinforced belts in sheave grooves matched to drive.

.2 For 0.25 KW (1/3 hp) to 7.46 KW (10 hp) motors use standard adjustable pitch drive sheaves, having plus/minus 10% range. Use mid-position of range for specified rpm.

.3 For over 7.46 KW (10 hp) motors, use sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Refer to Section 15600 and 15800 for fan requirements relating to V-belt, vari-pitch drives. Provide sheave of correct size as approved by Contract Adminstrator to suit balancing.

.4 Use minimum drive rating of two times nameplate rating on motor. Keep overhung loads under manufacturer's requirements on all prime mover shafts.

.5 With belt drive, provide motor slide rail adjustment plates, allowing for 150mm (6") minimum centre line adjustment.

.6 Obtain approval to use cast iron or steel sheaves secured to shafts with removable keys.

1.21 SCREWS, BOLTS AND FASTENERS

.1 Use standard commercial sizes and patterns with Material and finish suitable for service.

.2 Use heavy hex heads, semi-finished unless otherwise specified. Use non-ferrous Material throughout for plumbing services. Use type 304 stainless steel for exterior areas.

.3 Bolts used on fan equipment for access to motors, bearings, filters and the like shall be heavy-duty.

.4 Bolts shall not project more than one diameter beyond nuts.

.5 Washers

.1 Use plain-type washers on equipment, sheet metal and soft gaskets, lock-type washers where vibration occurs, and resilient washers with stainless steel.

1.22 SPECIAL TOOLS AND SPARE PARTS

.1 Furnish the The City with spare parts as follows:

.1 One glass for each gauge glass installed.

.2 One set of v-belts for each piece of machinery.

.3 One set of filters for each filter bank installed. ie. one set for both pre-filter and high efficiency filters.

.2 Identify spare parts containers as to contents and replacement parts number.

.3 Provide one set of all specialized tools required to service equipment as recommended by manufacturers.

1.23 TRIAL USAGE

.1 The City reserves right to use any piece of mechanical equipment, device or Material installed under this Contract, for such reasonable lengths of time and at such times as Contract Adminstrator may require, to make complete and thorough test of same, before final completion and acceptance of any part of Contract. It is agreed and understood, that no claim for damage will be made for any injury or breakage to any part or parts of the above due to aforementioned tests, whether caused by weakness or inaccuracy of parts, or by defective Materials or Workmanship of any kind whatsoever. Supply all labour and equipment for such tests.

1.24 SAFETY DEVICE TESTING

.1 Make complete inspection of all safety devices to ensure:

.1 That safety devices are complete and in accordance with Specifications and manufacturer's recommendations.

.2 That the safety devices are connected and operating according to all local regulations.

.2 Safety devices to be inspected shall include, but not be limited to:

.1 Pressure relief valves

.2 Freeze protection devices
.3 Refrigerant detectors

.3 On completion of inspections, supply to Contract Adminstrator letters and/or certificates for their record, confirming that inspections have been completed.

1.25 TEMPORARY USE OF EQUIPMENT

.1 Permanent systems and/or equipment not to be used during construction period, without Contract Adminstrator's written permission.

.2 Equipment used during construction period to be thoroughly cleaned and overhauled. Replace worn or damaged parts so equipment is in perfect condition, to entire satisfaction of Contract Adminstrator.

.3 Provide proper care, attention and maintenance for equipment while it is being used. If, in opinion of Contract Adminstrator, sufficient care and maintenance is not being given to equipment and systems, Contract Adminstrator reserves right to forbid further use of said equipment and systems.

.4 Temporary use of equipment shall in no way relieve Contractor of providing twelve month guarantee on all equipment so used this guarantee period to commence as of date of final acceptance of building by The City as interpreted by Contract Adminstrator.

.5 All air filters shall have bi-monthly inspection. Filters shall be cleaned and/or replaced depending on filter type during period in which ventilation units are being used for temporary heat and/or commissioning of system. Contractor to be responsible for and pay all costs for air filter cleaning service. Filters to operate between pressure drops noted in filter manufacturer's catalogue.

1.26 RECORD DRAWINGS

.1 Provide one set of Contract prints to form Record Drawings, marked clearly with all changes and deviations from piping and ductwork, including all Contract Changes.

.2 Update Record Drawings on a regular basis to ensure they are accurate, and have available for reference and inspection at all times.

1.27 TEMPORARY HEATING

.1 Obtain written permission from Contract Adminstrator to use permanent heating system for temporary heat. Operate systems in strict accordance with equipment manufacturer and Contract Adminstrator's recommendations.

1.28 PAINTING & IDENTIFICATION

.1 Finish painting of mechanical equipment, piping, ductwork and the like shall be performed by a competent painting Sub-contractor of Division 15 - Mechanical.

.2 Following areas shall have piping, ductwork, equipment and Materials painted:
.1 Machine Room.
.2 All roof top and outdoor exposed areas.

.3 Thoroughly clean off rust and oil, all exposed iron and steel Work of every description, including hangers, pipes, ducts, etc. paint with a coat of chrome oxide phenolic base primer and a coat of 100% Alkyd base enamel of approved colour. Paint exposed galv. metal surfaces in above areas with a coat of zinc dust galvanize primer and a coat of 100% Alkyd base enamel of approved colour.

.4 Paint exposed covering in above room and areas with two coats of 100% Alkyd base enamel of approved colour.

.5 All roof top and outdoor exposed mechanical equipment, ductwork, piping, etc. shall have base prime coat and two finish coats of top-quality, exterior rubber-based paint.

.6 After piping, etc. has been painted, paint neatly stencilled letters, about 25mm (1") high, designating pipe service and arrows showing direction of flow. Wording to be as later directed by Contract Adminstrator. Stencilling to occur at not more than fifty foot intervals. "Mystik" tape arrows and identification letters may be substituted, at discretion of Contract Adminstrator. Stencil all pipes at access doors also.

.7 All colours shall be approved by Contract Adminstrator. Existing system convention shall be maintained.

.8 Location of Piping Identification

- .1 Locate stencilling so that it can be seen from floor or platform.
- .2 Identify piping runs at least once in each room.
- .3 Do not exceed 15m (50 feet) between identification in open areas.
- .4 Identify on both sides where piping passes through walls, partitions and floors.
- .5 Location schedules:
  - .1 Where piping is concealed in pipe chase or other confined space, identify at point of entry and leaving, and at each access opening.
  - .2 Identify piping at starting and ending points or runs at each piece of equipment.
  - .3 Identify piping at major manual and automatic valves immediately upstream of valves. Where this is not possible, place identification as close to valve as possible.
- .6 Identify branch, equipment, or building served after each valve.

.9 Ductwork Identification

- .1 Use black 50mm (2") high stencilled letters (e.g. "Cold", "Hot", "Return", "Sanitary Exhaust", "Kitchen Exhaust") with arrow indicating air flow direction.
- .2 Distance between markings 15m (50') maximum.
- .3 Identify ducts on each side of dividing walls or partitions and beside each access door.
- .4 Stencil only over final finish.
- .5 Prior to installation, review general application of identification with Contract Adminstrator.

1.29 CUTTING AND PATCHING

.1 Cutting, patching and repairs to existing surfaces required as a result of the removal and/or relocation of existing equipment and piping, and/or installation of new equipment and piping in existing building(s) to be included by Div. 15 - Mechanical in Bid Opportunity price. Division 15 - Mechanical to employ and pay appropriate Sub-contractor whose Work is involved, for carrying out Work described above.

.2 Where services are concealed within walls, floors or ceilings and cannot be visually identified, Contractor shall provide electronic scanning devices or other approved means to locate and identify concealed services prior to drilling.

1.30 SALVAGE

.1 All mechanical equipment, ductwork, and piping disconnected as part of the Work and not required in new layout shall become property of Contractor and shall be removed from Site.

.2 Mechanical Drawings indicate most mechanical equipment to be removed and/or disconnected. Mechanical equipment not indicated on Drawings as being removed or disconnected, but which has to be removed due to removal of walls of existing building, to be removed and pipes capped off by Contractor at no additional cost.

1.31 CLEANING AND FLUSHING OF PIPING SYSTEMS

.1 On completion, each piping system shall be flushed out before installation of equipment, fixtures, etc. in order to remove any foreign Material in piping.

.2 Flush with water, unless noted otherwise in individual mechanical sections of Specifications.

.3 All plumbing fixtures and all equipment shall be thoroughly cleaned and left in first class operating condition.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Following Appendix of Manufacturers lists manufacturers of equipment and Materials acceptable to Contract Administrator, subject to individual clauses under the various sub-sections of Mechanical Work Specifications. See item 'Materials' under this section of Specification.

.2 Product noted in individual Specification clauses is an item that meets Specification in all respects regarding performance, quality of Material and Workmanship, and is acceptable to Contract Administrator without qualification. Equipment proposed from other manufacturers listed as 'Approved Manufacturers' and alternates shall meet same standards.

.3 Contractor to submit within forty-eight hours of notification from Contract Administrator, one (1) copy of fully and properly completed Appendix of Manufacturers listing thereon names of manufacturers of products which shall be used to execute Work of Contract. If list is not submitted within 48 hours, Contractor must use product named in each individual clause.

.4 Submit Shop Drawings for all items marked with asterisk(*).

1.2 EQUIPMENT OR MATERIAL & APPROVED MANUFACTURERS

.1 ELECTRIC MOTORS

.1 G.E.; Siemens; Tamper; Reliance; Leland; Lincoln; U.S. Electric; Century; Baldor; WEG; Toshiba

.2 INSULATION

.1	Pipe Insulation	Manville; Owens Corning; Knauf; Pabco; Fibreglas
.2	External Duct Insulation	Manville; Fibreglas; Knauf
.3	Lagging Adhesive/Coating	Bakor; Childers; Fosters
.4	Aluminum pipe jacket	Childers; Permaclad; Pabco
.5	PVC pipe jacket	Sure-Fit

.3 PLUMBING

.1	Grooved copper piping system*	Gruvlok; Victaulic
.2	Valves (ball)*	Toyo; Kitz; Nibco; Anvil
.3	Hangers and Supports	Anvil; Crane; Myatt
.4	Alignment Guides	Adsco; Flexon; Fulton; Yarway
.5	Dielectric	Watts
.6	Strainers*	Spirax-Sarco; Muessco; Toyo; Crane; Colton
.7	Expansion joints*	Fulton; Flexonics; Hyspan; Flextech
.8	Backflow preventers*	Watts; Conbraco; Ames

.4 LIQUID HEAT TRANSFER

.1	Welding fittings	Anvil; Crane; Tube Turn
.2	Malleable iron fittings, flange, flange gaskets	Crane; Gourd; Anvil; International Malleable
	.1 Mechanical joints*	Victaulic; Gruvlok
.3	Pipe hangers	Anvil; Crane; Myatt
.4	Gate, globe valves*	Crane; Toyo; Kitz; Nibco

.5	Check valves (up to 2" diam.)		
	.1	Horizontal piping*	Crane; Toyo; Kitz; Nibco
	.2	Vertical piping*	Durabla; Nibco
.6	Check valves (2-1/2" diam. & up)		
	.1	Horizontal piping*	Moyes & Groves; Chek-Rite; Keystone-Prince; Victaulic; Gruvlok
	.2	Vertical piping*	Val-Matic; Durabla; Victaulic; Gruvlok
.7	Butterfly valves*		Keystone; Center Line; Nibco; Victaulic; Jenkins; Gruvlok
.8	Ball Valves*		Toyo; Kitz; Nibco; Victaulic; Newman Hattersley; Jenkins; Anvil
.9	Balancing valves (up to 2")*		Toyo; Kitz; Anvil; Newman Hattersley
.10	Balancing valves (2½" dia & up)*		Keystone; Center Line; Nibco; Victaulic; Jenkins; Gruvlok
.11	Expansion joints*		Fulton; Flexonics; Hyspan
.12	Air vents*		Dole; Hoffman; Maid-O-Mist
.13	Strainers*		Spirax-Sarco; Mueller; Victaulic; Gruvlok; Colton
.14	Steam traps*		Spirax-Sarco; Hoffman; Armstrong; Watson McDaniel
.15	Thermometers*		Ashcroft; H.O. Trerice; Winters; Taylor; Weiss; Marshalltown
.16	Pressure gauges*		Kunkle; Winters; Ametek; Ashcroft; Trerice; Weiss; Marshalltown
.17	Safety valves (steam)*		Consolidated; Farris; Kunkle; Conbraco
.18	Relief valves (water)*		Conbraco; Spence; Farris
.19	Flexible pipe connectors*		Flexonics; Hydro-Flex; United Flexible
.20	Welded pipe backing rings*		Robvon; Anvil
.21	Vibration control*		Vibron; Vibro-Acoustic; Airmaster
.22	Water chiller*		Carrier; York; McQuay
.23	Cooling tower*		Marley; B.A.C.; Evapco
.5	AIR DISTRIBUTION		
	.1	Ducturns, damper hardware, fan connections*	Duro-Dyne
	.2	Duct Sealer	Duro-Dyne; 3M; Flexa-Duct; United; Bakelite
	.3	Filters*	A.A.F.; Camfill-Farr; Cambridge; Continental; Airguard
	.4	Air supply units*	McQuay; Carrier; York; EngAir
	.5	Belt driven in-line fans*	Greenheck; Loren Cook
	.6	Diffusers, registers & grilles*	E.H. Price; Hart & Cooley; Titus; Carnes; Nailor
	.7	Vibration control*	Airmaster; Vibro-Acoustics; Vibron; Kinetics
	.8	Backdraft damper*	Penn; Greenheck; Ventex
.6	CONTROLS/INSTRUMENTATION		
	.1	Temperature control system*	Honeywell; Johnson; Siemens-Landis; Delta
	.2	Gas detection sensor*	Q.E.L.; M.S.A.
	.3	Flow switch*	
		.1 (Fluid)	McDonnell & Miller
	.4	Flow sensors*	
		.1 (Fluid)	Contract Administratoring Measurements Co.

.7 H.V.A.C. BALANCE AND TESTING

.1 H.V.A.C. Balance & Testing Agency — Airdronics Inc.; DFC; AHS; Air Movement

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specification shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

.1 Labour, Material, plant, tools, equipment and services necessary and reasonably incidental to completion of external insulation for mechanical equipment, piping, ductwork.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 15010 Mechanical General Provisions

.2 Section 15051 Acceptable Materials & Equipment

.3 Section 15400 Plumbing

.4 Section 15600 Liquid Heat Transfer

.5 Section 15800 Air Distribution

Part 2 Products

2.1 MATERIALS

.1 All Materials shall be equivalent in all respects to specified products and shall be used only in applications intended by the manufacturer. Materials not specifically intended for the purpose shall not be used. Approved Materials shall not be diluted or blended with other Materials unless specifically recommended by the manufacturer of the approved Material.

.2 All final pipe and duct installations including insulation, covering and adhesive shall have a ULC Certified flame spread rating of not greater than 25, and a smoke developed classification of not more than 50.

.3 All canvas shall be treated to be fire retardant in accordance with ULC standards.

.4 Wire to be 1.2mm (18 ga.) stainless steel, dead soft annealed, type 304.

.5 U.L.C. label or satisfactory certified report from approved testing laboratory is required to indicate that fire hazard ratings for Materials proposed for use do not exceed those specified.

.6 Flameproofing treatments subject to deterioration due to effects of high humidity are not acceptable.

.7 Contract Administrator reserves the right to demand test samples of components of insulation systems for fire hazard test rating.

2.2 COMPATIBILITY OF COMPONENTS

.1 All adhesives, sealers, vapour coating, mastics, laggings and bedding compounds, shall be compatible with Materials to which they are applied. They shall not soften, corrode, or otherwise attack such Material in either wet or dry state and shall only be those recommended by manufacturer of insulation as suitable for application proposed. They shall be applied at ambient conditions acceptable to the manufacturer.

2.3 COLD INSULATION - PLUMBING

.1 Material

.1 On pipes 50mm (2") diam. and under, use 12mm (1/2") Fiberglas 112 kg/m(7 lb./cu. ft.) density pipe insulation with ASJ jacket.

.2 On pipes 62mm (2-1/2") diam. and larger, use 25mm (1") Fibreglas 88 kg/m(5-1/2 lb./cu. ft.) density pipe insulation with ASJ jacket, c/w vapor barrier.

.2 Location

.1 Condenser water lines from roof penetration to cooling tower to cover heat trace.

.2 Condenser water lines 2M from roof penetration into building.

.3 Cooling tower make up water line.

2.4 HOT INSULATION - HEATING

.1 Materials

.1 On piping 50mm (2") diam. and under, use 25 (1") Fibreglas 88 kg/m(5-1/2 lb./cu. ft) density pipe insulation with ASJ all service jacket and self seal lagging adhesive.

.2 On piping 62mm (2-1/2") diam. and larger, use 37mm (1-1/2") Fibreglas 88 kg/m.

.2 Location

.1 Steam piping.

.2 Condensate piping.

2.5 ALUMINUM INSULATION COVER

.1 Protective covering to be 0.020” ___ embossed aluminum pre-formed covering secured with 12mm (1/2”) stainless steel bonding at 300mm (12”) on centre.

.2 Location

.1 Exterior cooling tower make up water lines..

.2 Exterior condenser water lines.

.3 Exterior cooling tower drainage lines.

2.6 WHITE PVC INSULATION COVER

.1 Cover insulation and insulated fittings with white PVC fitting covers.

.2 The fitting cover system shall consist of one-piece pre-molded high impact PVC fitting covers with fiber glass inserts and accessories, including elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, jacketing, tacks, and PVC tape.

.3 Cover shall have a flame spread rating of not more than 25 and a smoke developed classification of not more than 50.

.4 Cover shall be resistant to and not promote growth of fungi or bacteria.

.5 Cover shall be UV resistant for use indoors or outdoors. Paint outdoor fittings for further UV and colorfast protection.

.6 Locations

.1 All chilled water pipe and fittings including valves, joints, elbows etc.

.2 Domestic water pipe and fittings.

2.7 CHILLED WATER PIPING INSULATION

.1 Material

.1 38mm (1 1/2") thickness Fibreglas 88 kg/m(5-1/2 lb./cu. ft.) density pipe insulation with ASJ all service vapor seal jacket with self seal.

.2 Location

.1 All chilled water piping including accessory apparatus.

2.8 VAPOUR BARRIER RIGID INSULATION

.1 Following ducts externally insulated with Fibreglas RFFRK reinforced foil-faced vapour seal duct insulation type FF 340 g. (4.5 lb./cu.ft.) density.

.1 50mm (2") Thickness

.1 All rectangular exhaust and relief ducts, for a length of 1.8m (6'-0") or from wall or roof discharge back to damper, whichever is greater.

.2 All outside air ductwork.

2.9 WATER CHILLER MACHINES INSULATION

.1 Insulate complete surface of water chiller machines evaporator water boxes, evaporator, support plates, motor housing and compression suction elbows with 18mm (3/4") Armstrong Armaflex AP sheet insulation adhered to evaporator with Armstrong 520 Adhesive. Apply adhesive to both insulation and steel surfaces. All seams to be sealed with 520 adhesive.

.2 Refinish with Armstrong Armaflex finish.

.3 Apply Armstrong Armaflex AP pipe insulation as described in item .1 above to all miscellaneous small refrigerant and water piping as directed by water chiller mfg. published installation manual.

.4 Evaporator water boxes insulation to be applied such that water box cover and its insulation can be removed without disturbing shell insulation.

.5 Section 15180 to contact water chiller suppliers for specific machine and piping insulation requirements. Conform to their insulation recommendations.

Part 3 Execution

3.1 WORKMANSHIP

.1 Work shall be performed by licensed journeymen.

.2 Apply insulation Materials, accessories and finishes in accordance with manufacturer's recommendations.

.3 Do not apply coverings until hydrostatic tests have been completed, surfaces are free of grease, scale, moisture, and heat tracing where required has been installed. Insulation shall be clean and dry when installed and during application of any finish.

.4 Apply insulation and coverings to equipment and piping which will operate with hot or warm liquid vapour, while surface is hot. Provide any required temporary heat to accomplish this.

.5 Cold surfaces to be dry and ferrous surfaces to be coated with rust penetrating protective paint before applying insulation and vapour barriers.

.6 Vapour barriers and insulation to be complete over full length of pipe or surface, without penetration for hangers, duct or seams, and without interruption at sleeves, pipe and fittings.

.7 Install insulation with smooth and even surfaces, with round shapes laid to true circular and concentric shape, shaped to blend with fitting insulation and adjacent covering; with full length section and tight to insulated object.

.8 Pack solid around all pipes where they pass through sleeves in walls, floor slabs, etc. for full thickness of floor with fibreglas or rockwool. Refer to firestopping clause where piping passes through fire separations. On all services, carry full insulation thickness through walls, floors, etc. Protect insulation of exposed pipes passing through floors with 1.2mm (18 ga.) galv. iron 150mm (6") from finished floor.

.9 On piping, gouge out insulation for proper fit where there is interference between weld bead and insulation. Bevel insulation away from studs and nuts to permit their removal without damage to insulation. Closely and neatly trim around extending parts of pipe saddles, supports, hangers and clamp guides. Seal with insulating cement.

.10 Use pipe covering protection saddles with roll type hangers unless otherwise indicated.

.11 Butt joints

- .1 Place joints on top of duct wherever practical. Butt joints on side of duct for flexible duct insulation.
- .2 Adhere and seal laps of vapour barrier cover or vapour barrier strip of 100mm (4") minimum width furnished with insulation, using vapour seal adhesives.

.12 Sagging of duct insulation will not be acceptable.

.13 Stagger both longitudinal and horizontal joints, on duct insulation of multilayered construction.

.14 Duct insulation with vapour barrier shall be continuous, except at fire dampers.

.15 Ducts acoustically lined need no external insulation, unless specifically noted otherwise.

.16 Existing duct and pipe covering damaged or cut back during installation Work to be made good with same insulation as specified for new Work.

.17 Protect insulation against elements during all stages of application.

.18 Do not cover manufacturer's nameplates. Cut insulation on 45 deg. angle to nameplate edge and seal.

.19 Covering to be uniform in diameter, smooth in finish. Place longitudinal seams so as to be invisible.

3.2 COLD INSULATION - PLUMBING

.1 Fibreglass

.1 Insulate flanges, fittings and valve bodies, etc.

.2 Fasten longitudinal laps with staples and seal with Swifts Adhesive #3218.

.3 Butt joints wrapped with a 100mm (4") strip of ASJ. Stagger joints on multiple layers.

.4 Refinish exposed piping with canvas and coat with Bakor 120-18 white fire retardant lagging adhesive.

.5 All fittings shall be insulated by wrapping with 25mm (1") thick layers of 340 g. (3/4 lb.) density flexible fibreglass attached with jute twine. Surface shall be wrapped with Friction Tape and sealed with and asphaltic sealing compound. Over this to be applied a smooth coating of insulating cement. Recover fittings with ASJ vapour seal jacket and brush coat with fire retardant white lagging adhesive.

3.3 HOT INSULATION - HEATING

.1 Application as per Clause "Cold Insulation- Plumbing".

.2 Insulate flanges, fittings and valve bodies, etc.

.3 Fasten longitudinal laps with staples and seal with Swifts Adhesive #3218.

.4 Butt joints wrapped with a 100mm (4") strip of ASJ. Stagger joints on multiple layers.

.5 Refinish exposed piping with canvas and coat with Bakor 120-18 white fire retardant lagging adhesive.

.6 All fittings shall be insulated by wrapping with 25mm (1") thick layers of 12 kg/m(3/4 lb./cu.ft.) density flexible fibreglass attached with jute twine. Surface shall be wrapped with Friction Tape and sealed with and asphaltic sealing compound. Over this to be applied a smooth coating of insulating cement. Recover fittings with ASJ jacket applied

directly over the smooth coat of cement. Brush coat with Bakor 120-18 white fire retardant adhesive.

3.4 WHITE PVC INSULATION COVER

.1 Preparation

.1 Proto Fitting Covers shall be applied on clean, dry surfaces.

.2 Application

.1 General

.1 The matching fiber glass insert shall either be wrapped completely around the fitting or snugly positioned inside the Proto Fitting cover for proper fit. The insert shall cover the full inner surface area of the Proto Fitting Cover. The Proto Fitting Cover shall then be applied over the fitting and insert, and the throat secured by either tack fastening, taping, sealing with a solvent type PVC adhesive, or banding.

.2 Cold Pipe

.1 Fitting systems below ambient temperature must have a continuous vapor retarder, either with Proto PVC Tape, Proto Butt Strips, Proto PVC Adhesive, or a vapor retarder mastic as specified by the Contract Administrator. When using Proto PVC Tape, a 2" (51mm) minimum downward overlap is recommended for optimum performance. Care should be taken not to stretch the last 2" (51mm) of Proto PVC Tape, to avoid stretching or creeping.

.3 Hot Pipe

.1 Insulate as per General Instructions given above. Due to PVC softening point at approximately 150 deg. F (70.6 deg. C), care should be taken to ensure sufficient insulation thicknesses are applied. For hot piping which requires Knauf Pipe insulation over 1-1/2" (38mm) wall thickness, an extra fiber glass insert shall be applied for each additional inch of pipe insulation wall thickness. Knauf recommends the surface temperature of the pipe insulation and PVC to be no higher than 125 deg. F (52 deg. C). To complete application of Proto PVC Fittings on hot piping, the throat seam shall be riveted or tacked.

.4 Outdoor Pipe

.1 Insulate as per above instructions. When installing Proto PVC fittings outdoors, add one layer aluminum foil over the first fiberglass insert applied, making sure the aluminum foil is extended over the adjacent pipe insulation. A second fiber glass insert shall then be applied over the aluminum foil, and the Proto PVC fitting applied.

.2 Minimum Proto PVC jacketing thickness for outdoor application should be .020" (.5mm). The PVC jacketing shall be overlapped a minimum of 2" (51mm) on the down side so as to shed water. Longitudinal joints shall be completely weather sealed with solvent type PVC sealer. Circumferential joints shall be wrapped with a minimum 2" (51mm) wide butt strips and completely sealed using a solvent type PVC sealer. On hot piping, insulation shall be of sufficient thickness to keep the surface temperature below 125 deg. F (52 deg. C). Additionally, a slip

type expansion joint of 4" (101mm) minimum width shall be applied at least every 20 lineal feet (6.1 lineal meters).

3.5 COLD INSULATION - CHILLED WATER PIPING

.1 Application as per Clause "Cold Insulation - Plumbing".

.2 Insulate flanges, fittings and valve bodies, valve bonnets, etc.

.3 Fasten longitudinal laps with staples and seal with Swifts Adhesive #3218.

.4 Butt joints wrapped with a 100mm (4") strip of ASJ. Stagger joints on multiple layers.

.5 Refinish exposed piping with canvas and coat with Bakor 120-18 white fire retardant lagging adhesive.

.6 All fittings shall be insulated by wrapping with 25mm (1") thick layers of 12 kg/m(3/4 lb./cu.ft.) density flexible fibreglass attached with jute twine. Surface shall be wrapped with Friction Tape and sealed with and asphaltic sealing compound. Over this to be applied a smooth coating of insulating cement. Recover with ASJ vapour barrier jacket. Refinish with brush coat of Bakor 120-18 white fire retardant lagging adhesive.

3.6 VAPOR BARRIER RIGID DUCT INSULATION

.1 Insulation applied with edges tightly butted and secured by impaling on pins welded to duct. Pins to be staggered, minimum 300mm (12") o.c. in every direction. This applies to all sides. Secure insulation to pins with metal fasteners. Pins shall be long enough to bend after fasteners have been applied. Install two fasteners to all insulation on roof. Dab adhesive over pins and fasteners.

.2 Seal all joints, edges and breaks in vapor seal jacket with vapor barrier foil of the same quality as that of duct membrane 100mm (4") wide with BF 85-15 lagging adhesive.

.3 Exposed Ducts

.1 Recover ducts exposed to view with 170 g. (6 oz.) canvas secured with Bakor 120-18 white fire retardant lagging adhesive. Finish with brush coat of same adhesive.

.4 Outdoor Ducts

.1 On roof and other ductwork located outside of building, provide 26 ga. G.I. sheet metal cover to protect insulation. Seal all joints and make weathertight.

.2 On square or rectangular ductwork provide slight peak along top centre line so moisture will run off.

3.7 WATER CHILLER INSULATION

.1 Apply adhesive to both insulation and steel surfaces. All seams to be sealed with 520 adhesive.

.2 Evaporator water boxes insulation to be applied such that water box cover and its insulation can be removed without disturbing shell insulation.

.3 Section 15180 to contact water chiller suppliers for specific machine and piping insulation requirements. Conform to their insulation recommendations.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

.1 Provide labour, Material, equipment and services necessary for and incidental to the supply and installation of the systems shown on the Drawings and hereinafter specified.

.2 Generally this shall include:
- .1 Sanitary Drainage System
- .2 Cold and Hot Water Supply System

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 15010 Mechanical General Provisions

.2 Section 15051 Acceptable Materials & Equipment

.3 Section 15180 Insulation

.4 Section 15600 Liquid Heat Transfer

.5 Section 15800 Air Distribution

.6 Section 15900 Controls/Instrumentation

.7 Section 16010 Electrical General Provisions

Part 2 Products

2.1 PIPE AND FITTINGS

.1 General
- .1 All pipe & fittings shall be manufactured in North America.
- .2 Pipe and fittings shall conform to the standards listed in the applicable Building Code (latest revision).
  - .1 Flanged joints must have suitable gasket and bolts.
  - .2 Use brass nipples between copper piping and flush valves or c.p. brass goods.
  - .3 Where alternate piping Materials or jointing are specified a uniform type of pipe and fittings shall be used throughout each system.
- .3 Drains and vents
  - .1 Drains and vent pipes shall be in accordance with local or provincial regulations with the following exceptions, unless otherwise specified.
  - .2 No plastic, asbestos cement or aluminum pipe will be accepted unless specifically called for by the Contract Administrator.
- .4 Water Piping - Domestic Cold
  - .1 Pipe - Type 'L' third party certified hard copper tube to ASTM B.88.
    Fittings - Wrought copper or cast brass, solder joint pressure fitting.
    Flanges - Cast brass 1034 kPa (150 lb.) ANSI B16.24.

2.2 VALVES

.1 General

.1 Valve parts must be of Material recommended by mfg. for service specified. Valves must be installed with stems upright or horizontal, not inverted. Valves not specifically covered herein shall be of comparable quality to those specified.

.2 Water

.1 Domestic cold

.1 Ball valves up to 50mm (2"): Toyo Fig. 5049A, Newman Hattersley 1979, Kitz 59, Crane 9322, Nibco S-585-70.

2.3 STRAINERS

.1 Water Systems:

.1 Up to 50mm (2") size - screwed bronze body Y pattern, with stainless steel perforated screen Newman Hattersley 807, Spirax Sarco Type BT.

2.4 EXPANSION JOINTS

.1 Copper Pipe sizes 75mm (3") and under:

.1 FLEXONICS Model HB bronze expansion compensators designed for the pressure to be external to the 2-ply bronze bellows for positive squirm elimination, and complete with anti-torque device, limit stops, internal guides with female streamline ends. All brazed joints to be by heliarc process.

.2 Anchors and guides in contact with copper pipe shall be copper, or copper-plated.

.3 Guides shall be FLEXONICS pipe alignment guides.

2.5 CLEANOUTS

.1 Cleanouts in copper drainage: Brass screwed plugs with raised head.

2.6 CLEANOUT ACCESS COVERS

.1 Heavy traffic unfinished areas:

.1 Zurn Z-1425-24 heavy duty cast iron cover and frame, with securing screws.

Part 3 Execution

3.1 GENERAL INSTALLATION

.1 Copper pipe shall not be buried except where specifically noted on Drawings.

.2 All pipe shall be cut accurately to measurements taken at Site , installed without springing or forcing. All changes in direction made with fittings.

.3 All connections to equipment made with unions or flanges.

.4 Remove valve Working parts during installation to prevent damage from heat where brazing, soldering, or welding is used.

.5 Comply with latest CSA Standard W117.2 "Code for Safety in Welding and Cutting".

.6 Drain pipes dropping into slab on grade shall have sisson joint arranged to take up movement of slab.

.7 Run all piping in accessible pipe spaces in such a way that it does not interfere with free access into pipe space.

.8 Co-operate with all Sub-contractor to properly locate all equipment connections.

.9 Provide a shutoff valve on supply connections at each piece of equipment.

3.2 DRAINAGE SYSTEMS

.1 Sanitary Drains

.1 Provide complete systems of sanitary drainage and venting to serve all equipment. This includes local drains from equipment in Contract such as cooling tower, etc.

.2 Run building sanitary drain from connection point outside building as noted on Drawings.

.3 Cleanouts:

.1 Install cleanouts at all changes of direction, at intervals of not over 15m (50') in horizontal runs, at all points where obstructions might be formed and at points required by plumbing regulations or shown on Drawings.

.2 Cleanouts shall be accessible. Cleanouts above furred ceilings or in concrete slabs on grade shall be extended to floor level with cleanout access cover and frame.

.4 Flash vents through roof in approved manner.

3.3 WATER SUPPLY SYSTEM

.1 General

.1 Provide complete system of water supply piping to serve all equipment, etc.

.2 Grade horizontal runs of piping to drain through risers.

.3 Install shut off valves at all connections to major pieces of equipment.

.4 Install dielectric insulating unions between all pipes or apparatus constructed of dis-similar metals.

.2 Backflow Preventers

.1 Provide approved backflow preventers on all potable water supplies as noted on Drawings, specified herein, or as required by provincial/municipal authorities.

.2 Test backflow preventers in accordance with manufacturer's recommendations, Contract Administrator or as required by provincial/ municipal authorities.

3.4 JOINTING

.1 All joints shall be made in accordance with manufacturer's recommendations.

.2 Joints in copper drainage and water tube shall be in strict accordance with manufacturer's published recommendations and as follows:

.1 Water tube up to and including 50mm (2") and drainage tube all sizes shall be lead free solder consisting of tin, copper and silver (Silvabrite 100 or equal in accordance with B6).

3.5 EXPANSION AND CONTRACTION OF PIPING

.1 Make provision for expansion and Contraction of all piping. Use swing connections where shown or necessary.

3.6 CLEANING AND FLUSHING

.1 On completion, flush out piping systems before installation of equipment, fixtures, etc. in order to remove any foreign Material in piping.

.2 Clean out all plumbing fixtures and equipment and leave in first class operating condition.

3.7 TESTING

.1 All piping systems shall be pressure tested as follows:

- .1 Plumbing and drainage - in accordance with local regulations.
- .2 Water supply piping - test with water to 690 kPa (100 psig) at the highest point of system. Maintain pressure without loss for 4 hours.
- .3 General
  - .1 All systems and equipment will be subject to operating tests to verify that they operate properly, as directed by Contract Administrator. This will apply to pumps, heaters, compressors, and complete systems generally.
  - .2 Contract Administrator's representative shall witness tests. Give 48 hours notice in advance of all tests.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

.1 Labour, Materials, plant, tools, equipment and services necessary for and reasonably incidental to completion of following services:
- .1 steam and condensate systems
- .2 chilled water systems
- .3 condenser water

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 15010 Mechanical General Provisions

.2 Section 15180 Insulation

.3 Section 15400 Plumbing

.4 Section 15800 Air Distribution

.5 Section 15900 Controls/Instrumentation

.6 Section 15990 Testing, Adjusting and Balancing

.7 Section 16010 Electrical General Provisions

Part 2 Products

2.1 PIPE AND FITTINGS

.1 All pipe & fittings shall be manufactured in Canada or the U.S.A.

.2 Low Pressure Steam, Condenser Water, Chilled Water.
- .1 Pipe Diameter:
  - .1 13mm to 250mm (1/2" to 10")- Schedule 40 carbon steel, continuous weld or electric resistance weld pipe conforming to A.S.T.M. A53 Grade B.
  - .2 All condensate piping to be Schedule 80 to Specifications as above.
- .2 Fittings
  - .1 Unions to be brass to iron ground joint type. Screwed fittings on steel pipe to be best quality 1034 kPa (150 psi) black malleable iron, banded. Nipples to suit pipe type. Thred-O-Lets and Weld-O-Lets to be manufactured to ASTM A181, Grade 1.
  - .2 Butt welding fittings to be Crane manufactured to ASTM A-234. Flanges to be Grinnell forged carbon slip-on welding flanges conforming to ASTM A181, Grade 1. Gaskets to be preformed non-asbestos. Site or shop cut gaskets unacceptable. Use ring gaskets on raised face flanges and full faced gaskets on flat face flanges. Use 1034 kPa (150 psi) flanges on water and low pressure steam systems to 682 kPa (99 psi). Above 682 kPa (99 psi) use 2069 kPa (300 psi) flanges.

2.2 VICTAULIC PIPING CHILLED AND CONDENSER WATER SYSTEMS

.1 All pipe & fittings shall be manufactured in Canada or the U.S.A.

.2 Section 15600 may use mechanical grooved pipe coupling, fittings and butterfly valves, shall be manufactured by Victaulic, for piping systems and mechanical equipment connections (in lieu of welded, flanged, threaded methods) (and may also be used as unions, seismic joints, flexible connections, expansion compensators, vibration reducers) in systems specified.

.3 In systems 2" and larger couplings shall be style 07, 77, 72, 750, 90, 99 and used where applicable. For rigid systems couplings shall be Style 07 Zeroflex complete with angle bolt pad design.

.4 Supply E.P.D.M. Grade 'E' gaskets, with green colour code identification, conforming to ASTM D-2000 designation 2CA615A15B44F17Z.

.5 Fittings shall be grooved end design to accept specified Victaulic couplings without field preparation, such as Victaulic flow fittings. All grooved components shall be of one manufacturer.

.6 Use Victaulic Vic-Flanges for connecting flanged components into grooved system.

.7

.1 Valves, grooved-end type, 25mm (1") to 300mm (12") diameter.
.2 Butterfly valves 150mm (6") and smaller to be Series 700 with latch-lock throttling handle Grade 'E' coated disc and standard trim, complete with PPS lining.
.3 Butterfly valves 200mm (8") through 300mm (12") to be Series 300 with manual gear operator, Grade 'E' coated disc and standard trim, complete with PPS lining.

.8 Supply pipe grooved in accordance with Victaulic Specifications. For grooving on-site, prepare pipe in accordance with same Specifications using specially designed tools.

2.3 VALVES

.1 Schedule of Valves

.1 All valves of each type specified shall be of one manufacturer. Submit brochure of valves selected, showing make, figure numbers, Material of construction and use.
.2 All valves shall conform to the requirements of the Manufacturers Standardization Society (MSS).

.2 Globe Valves - 0 to 682 kPa (0 to 99 psi)

.1 Sizes Up To and Including 50mm (2") - Screwed Ends: Straight - Crane Fig. 7TF, Toyo Fig. 221, Kitz Fig. 09, Nibco Fig. T-235Y, Grinnell Fig. 3240, Newman Hattersley Fig. 13 or Jenkins Fig. 106BJ. Angle - Crane Fig. 17TF, Kitz Fig. 38, Nibco Fig. T-335Y or Jenkins Fig. 108BJ. All valves to have Teflon discs.
.2 Sizes 64mm (2-1/2") and above - Flanged Ends: Straight - Crane Fig. 351, Toyo Fig. 400A, Nibco Fig. F-718-B, Grinnell Fig. 6200A, Newman Hattersley Fig. 731 or Jenkins Fig. 2342J. Angle - Crane Fig. 353, Kitz Fig. 76, Nibco Fig. F-818-B or Jenkins Fig. 2344J.

.3 Globe Valves - 689 kPa (100 psi) and above

.1 Sizes Up To and Including 50mm (2") - Screwed Ends: Straight - Toyo Fig. 214, Kitz Fig. 17S, Nibco Fig. T-276-AP, Newman Hattersley Fig. 14, Grinnell Fig. 3270 or Jenkins Fig. 2050J.

.2 Sizes 64mm (2-1/2") and Above - Flanged Ends: Straight - Crane Fig. 21E, Kitz 300 SCJ, Nibco Fig. F-768-B, Grinnell Fig. 6250A, Newman Hattersley Fig. C1882or Jenkins fig. 162J.

.4 Globe Valves - Steam and Condensate

.1 Sizes up to and including 50mm:

.1 Velan Fig. S-2074B-02TY or Crane B-3644XU-T with plug disc and screwed forged steel body rated at 5516 kPa. Disc and seat to be of 13% Cr stainless steel with seat being hard-faced with Stellite.

.5 Gate Valves 0 to 682 kPa (0 to 99 psi)

.1 Sizes up to and including 50mm (2") - Screwed Ends - Crane Fig. 428, Toyo Fig. 293, Kitz Fig. 24, Grinnell Fig. 3010, Nibco Fig. T-111 or Jenkins 810J.

.2 Sizes 64mm (2-1/2") and above - Flanged Ends - Crane Fig. 465, Toyo Fig. 421E, Kitz Fig. 72, Grinnell Fig. 6020A, Nibco Fig. F-617-O, Newman Hattersley Fig. 504 or Jenkins fig. 454J.

.6 Butterfly Valves

.1 Valves to be rated at 1034 kPa (150 psig) with cast iron body, aluminum bronze disc, stainless steel shaft, Buna N shaft seals, E.P.D.M. seat, extended neck design allowing valve operator to clear insulation, bubble-tight shut-off to 1034 kPa (150 psig).

.2 Valves 200mm (8") and smaller to have lever-lock handles with 10-position throttling plates.

.3 Valves 250mm (10") and larger to have gear operators with position indicator.

.4 Butterfly valves shall be considered equal to gate valves for chilled water and condenser water installations.

.5 On flanged piping at all equipment (pumps, coils, chillers, boilers and the like), use valves conforming to requirements of above with fully tapped body lugs so that valve can be connected individually to adjacent flanges.

.6 Keystone Fig. AR2, Centre Line Series 200 Lug Body, Grinnell Series 8000 lug body or Nibco Fig. LD-2000.

.7 Ball Valves

.1 Valves to have brass body, screwed ends, brass ball and stem and teflon seating seal (175 deg. C).

.2 Ball valves shall be considered equal to gate valves for low pressure condensate, chilled water and condenser water installations.

.3 Toyo Fig. 5044A, Kitz Fig. 58, Grinnell Fig. 171N, Nibco Fig. T-FP600, Newman Hattersley Fig. 1969, Victaulic 721, 722 or Jenkins Fig. 201J.

.8 Check Valves - Steam, Condensate Services

.1 Sizes up to and including 50mm - (0-682 kPa)

.1 Toyo Fig. 236 or Crane Fig. 37, bronze swing check valve, Y pattern, bronze disc., threaded-ends, rated 862 kPa S.W.P.

.9 Drain Valves - 3/4" Toyo Fig. 5046, Kitz Fig. 68C.C. c/w brass cap and chain, Newman Hattersley Fig. 1969 c/w brass cap and chain or Jenkins Fig. 201J c/w brass cap and chain.

.10 Balancing Valves

.1 Sizes up to 50mm (2") - ball valves as follows: Toyo Fig. 5044A, Kitz Fig. 58 c/w balance plate, Newman Hattersley Fig. 1969 c/w balance plate, or Jenkins Fig. 201J c/w balance plate and memory stop.

.2 Sizes 64mm (2-1/2") and above - Butterfly valves as listed previously except that valves 8" and smaller to have infinite position balancing plate and valves 10" and larger to have memory stops.

2.4 EXPANSION JOINTS

.1 On piping up to and including 64mm (2-1/2") diameter, FLEXONICS packless expansion compensators, having type 321 stainless steel bellows, suitable for traverse up to 44mm (1-3/4"), c/w guide sleeve and traverse stops. Expansion compensators up to and including 50mm (2") to have screwed ends or flanged ends; expansion compensators of 64mm (2-1/2") in size or larger to have flanged ends. Compensators to be external type 'H'.

.2 On piping of 75mm (3") and above, Flexonics packless self-equalizing single expansion joints, with type 304 stainless steel bellows. Sizes 75mm (3") and above to be externally guided with flanged ends.

.3 Guides to be Flexonics.

.4 Expansion joints shall be selected on the following basis:

.1 Low pressure steam - 120 deg.C temp. rise.

.2 Chilled water - 30 deg.C temp. rise.

2.5 FLEXIBLE PIPE CONNECTIONS

.1 On chilled and condenser water piping provide Flexonics style 102 twin sphere connectors manufactured of synthetic rubber tube and covered with nylon tire cord reinforcement and 1034 kPa (150 lb.) zinc plated, mild steel, floating flanges. Connectors to be 1476 kPa (214 psi) Working pressure at 82 deg.C (180 deg.F) and be suitable for use at temperatures up to 115 deg.C (239 deg.F) at reduced pressures.

.2 Provide Vibro-Acoustics VH spring hangers.

.3 Location

.1 Chilled and condenser water connections to water chiller.

.2 Connections to cooling tower.

2.6 AIR VENTS

.1 Chilled Water Services

.1 Manual air vents: Dole #14 key-operated air vent rated at 1034 kPa (150 psig) with copper tube extensions or Dole #9 screwdriver operated air vent rated at 1034 kPa (150 psig).

.2 Automatic air vents: Dole #75 automatic float air vent rated at 1034 kPa (150 psig).

.2 Condensate

.1 Install at high points and where noted on Drawings a gate valve as specified for the particular service.

.2 Install brass plug in outlet of all valves.

2.7 STRAINERS

.1 Strainers shall be Spirax Sarco type YS-250 or Toyo Fig. 380 for sizes up to and including 50mm (2") screwed ends.

.2 On pipe sizes 64mm (2-1/2") and larger, use Spirax Sarco type CI-125 and F-125, Kitz Fig. 80 or Toyo Fig. 381A for systems operating below 689 kPa (100 psig) and use Spirax Sarco extra heavy type CI-250 and F-250 for systems operating at 689 kPa (100 psig) and above.

.3 Screens shall be stainless steel with perforations as follows:

Size	Water/Glycol	Steam
Up to 3"	20 MESH	20 MESH
4" to 6"	1/8"	3/64"
8" to 18" (CI-125, F-125)	1/8"	1/16"
8" to 18" (F-250)	1/8"	3/64"

2.8 STEAM TRAPS

.1 Size steam traps on basis of three times apparatus load and 13.8kPa (2 psi) differential. Submit steam trap schedule for all air handling unit coils and converters, listing size, steam consumption and pressure differential.

.2 Steam Trap Schedule

.1 Pressures to 103 kPa (15 psi) - Spirax Sarco type FT15 float and thermostatic steam traps, cast iron body and inner Working parts and air vent of stainless steel.

2.9 THERMOMETERS

.1 Ashcroft Series EI bi-metal dial thermometers, having stainless steel cases, rings, and stems, glass covers and adjustable pointers. Accuracy to be 1% of full span.

.1 Chilled water systems - minus 5 deg. C to 50 deg.C.

.2 Condenser water systems - 0 deg.C to 50 deg.C.

.2 All thermometers to have 125mm (5") diameter dials. Use back or bottom inlet stems, whichever is best suited for ease of reading. Choice of stem types shall not be made until piping and equipment, etc. has been installed. Stem type to be approved by Contract Administrator.

.3 Brass separable wells to have insulation extensions, where mounted on insulated piping or equipment, to ensure dials are clear. Minimum length of stems to be 150mm (6").

2.10 PRESSURE GAUGES

.1 Ashcroft type 1010 quality gauges having aluminum cases, bronze geared movements, bronze bourdon tube, friction glass cover, steel slip ring, precision type pointer. Accuracy to be 1% of full scale.

.2 Use 113mm (4-1/2") dials. Where mounted above 3m (10') from floor level, use 150mm (6") dial. Gauges to be chosen with indicating needle at 12 o'clock position for normal operating pressure. Gauges shall have dual indication (i.e. kPa, psi) with kPa prominent figure.

.3 Provide Ashcroft Fig. DH-11 brass needle valve on gauges on water and glycol systems.

.4 Provide Jenkins Fig. 810 gate valves on gauges on steam systems operating at pressures up to 103 kPa (15 psig).

.5 Provide Jenkins Fig. 2036-A globe valve with #304 disc on gauges on steam systems operating at pressures above 103 kPa (15 psig).

.6 On all steam system gauges provide Ashcroft Fig. 1100 coil syphon rated at 1723 kPa (250 psig) minimum Working pressure at 232C (450F).

.7 Provide Ashcroft Fig. 1/4-1106B pulsation dampener on pump gauges.

2.11 AIR HANDLING UNIT

.1 General

.1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

.2 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.

.3 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close proximation to the intent of this Specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as $_{C}$ETL, ETL$_{US}$, UL, CSA prior to shipment.

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

.5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.6 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.7 Air Handling Units shall be as manufactured by Engineered Air and be base bid. Alternate products must show savings and clearly indicate all areas where they do not meet specified product.

.2 Unit Construction

.1 Unit casing shall be of minimum 18 gauge (1.3mm) 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. All joints shall be caulked with a water resistant sealant.

.3 Units shall be provided with access doors to the following components: fans, motors and filters. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.4 Units shall be provided with hinged access doors, with extruded neoprene gasket, fully lined, and a minimum of two camlock fasteners for all units up to 48 in. (1220 mm) high.

.5 All units shall be internally insulated with 1"(25mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density, neoprene coated fibre glass thermal insulation.

.6 1 1/2 lb./cu.ft. (24 kg/cu.m.) insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges.

.7 Unit shall be provided with ½"(13mm) holes in the base channels to accommodate hanger rods (rods supplied by others).

.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 selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Fans shall be equipped with permanently lubricated cartridge ball bearings, supported by a 3 point "spider" bearing bracket in the fan inlets.

.3 Drives shall be adjustable. All drives shall be provided with a rust inhibiting coating.

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

.5 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type. Use of separate bumper or snubber is not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.6 All single-phase belt drive motor applications shall include rubber isolation for motors ¼ H.P. (.19kw) through 1 ½ H.P. (1.1kw). Provide internal spring isolation for single phase motors over 1 ½ H.P. (1.1kw).

.7 Fan motors shall be ODP open drip proof type.

.4 Coils

.1 Coils shall be 5/8" O.D. as manufactured by Engineered Air, constructed of copper tube, aluminum fin, and copper headers with schedule 40 steel pipe connectors.

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

.3 Headers with schedule 40 steel pipe connections utilize male N.P.T. up to 4"(100mm) connections.

.4 Coils shall be removable from the unit at the header end unless shown otherwise on the Drawings.

.5 Coils shall be cleanable type provided with brass fittings and removable plugs for each tube at the return endheader end. Cast iron headers must have brass plugs to prevent oxidization.

.6 5/8” O.D. tube diameter water coils shall be ARI Certified.

.7 Coils shall be constructed of 5/8"(16mm) heavy wall copper tubing. Supply headers to be top horizontal with condensate headers at bottom of coil.

.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 Filter banks shall be designed such that filters slide out of the unit. Side removal 2" (50mm) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.

.3 2"(50mm) Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. The filter media shall have a minimum efficiency of 20-25% on ASHRAE Standard 52.1-92, and a minimum of MERV 6 per ASHRAE 52.2. Rated U.L. Class 2.

.4 Filter media shall meet UL Class 2 standards.

.6 Factory Supplied Controls/Wiring

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

.2 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

.3 Controls shall be housed in a control panel.

.4 Provide the following terminalized points of control:

.5 Unit on/off

.6 Fan low speed

.7 Fan high speed

2.12 CHILLER

.1 General

.1 Summary

.1 Section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

.2 ReferencesComply with the following codes and standards:

.1 ARI 550/590

.2 OSHA as adopted by the State

.3 ASME Section VIII

.4 NEC

.5 ANSI/ASHRAE 15

.3 Submittals

.1 Submit Shop Drawings and product data in accordance with Specification requirements.

.2 Submittals shall include the following:

.1 Dimensioned plan and elevation view Drawings, required clearances, and location of all field connections.

.2 Summary of all auxiliary utility requirements such as electricity, water, etc. Summary shall indicate quality and quantity of each required utility.

.3 Single line schematic Drawing of the field power hookup requirements, indicating all items that are furnished.

.4 Schematic diagram of control system indicating points for field connection. Diagram shall fully delineate field and factory wiring.
.5 Installation manual.

.4 Quality Assurance
.1 Qualifications: Equipment manufacturer must specialize in the manufacture of the products specified and have five years experience with similar equipment and the refrigerant offered.
.2 Regulatory Requirements: Comply with the codes and standards specified.
.3 Chiller manufacturer must be ISO Registered.

.5 Delivery and Handling
.1 Chillers shall be delivered to the job Site completely assembled and charged with refrigerant and oil by the manufacturer.
.2 Comply with the manufacturer's instructions for rigging and handling equipment.

.6 **Warranty**
.1 **The refrigeration equipment manufacturer's warranty shall be for a period of two (2) years from date of equipment start up. The warranty shall include parts and labor costs for the repair or replacement of defects in Material or Workmanship. The refrigerant warranty shall match the parts and labour warranty.**

.7 Service Package
.1 Include a 2-year Service package, to include seasonal start-up, mid-season check and seasonal shut-down.

.8 Maintenance
.1 Maintenance of the chillers shall be the responsibility of The City.

.2 Products
.1 Acceptable Manufacturers:
.1 McQuay International

.2 Unit Description
.1 Provide and install as shown on the plans a factory-assembled, factory charged, water-cooled packaged chiller. Each unit shall be complete with a single-stage hermetic centrifugal compressor with lubrication and control system, factory mounted starter, evaporator, condenser, refrigerant control device and any other components necessary for a complete and operable chiller package.Each chiller shall be factory run-tested on an AHRI certified test stand with water at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power shall be tested with a 50-Hz power supply.Any deviation in performance or operation shall be remedied prior to shipment and the init retested if necessary to confirm repairs or adjustments.

.3 Design Requirements
.1 General:
.1 Provide a complete water-cooled hermetic compressor centrifugal water chiller as specified herein. Machine shall be provided according to standards, Section 1.2. In general, unit shall consist of compressor, refrigerant condenser and evaporator, lubrication system, starter and control system. Note:

Chiller shall be charged with a refrigerant such as HFC-134a, not subject to the Montreal Protocol and the U. S. Clean Air Act.

.2 Performance:

.1 Performance shall be in accordance with applicable ARI Standards.

Unit Tag	Model No.	Capacity	Power	Refrigerant
CH-1	WSC087LBC35D	350 tons	575/3/60	R134A

Unit Data	Evaporator	Condenser
EWT (°F):	51.99	85.00
LWT (°F):	42.00	94.23
Flow Rate (gpm):	840	1050
Pressure Drop (ft):	17.3	11.1
Fluid Type (%):	WATER	WATER
Circuit No. of Passes:	2	2
Fouling Factor (ft² °F hr / Btu):	0.00010	0.00025
Tube No. / Description:	271 - 0.025" Enhanced Copper	260 - 0.025" CSL Enhanced Copper
Design Working Pressure (psig)	150	150

Performance Data		Electrical Data		Other	
Job KW	215.98	Motor FLA	238 A	Op weight	16112 lbs
KW/Ton	0.617	LRA	1815 A	Ref. Wt.	1067 lbs
NPLV	0.413	Inrush Amps	286 A	Shipping Wt	14359 lbs
		MCA	302 A		
		Max Fuse/ Breaker	421 A		
Starter Type: **Variable Speed Drive (complete with harmonic filters)**					

.3 Acoustics:

Octave Band								
63	125	250	500	1000	2000	4000	8000	dBA
69	67	69	72	76	79	79	74	84.5

.1 Sound pressure levels for the unit shall not exceed the following specified levels. The manufacturer shall provide the necessary sound treatment to meet these levels if required. Sound data shall

be provided with the quotation. Test shall be in accordance with ARI Standard 575.

.4 Chiller Components

.1 Compressors:

.1 Unit shall have a single-stage hermetic centrifugal compressors. Casing design shall ensure major wearing parts, main bearings and thrust bearings are accessible for maintenance and replacement. Lubrication system shall protect machine during coast down period resulting from a loss of electrical power.

.2 The impeller shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed 0.14 IPS.

.3 Movable inlet guide vanes actuated by an internal oil pressure driven piston shall accomplish unloading. Compressors using an unloading system that requires penetrations of the compressor housing or linkages, or both, that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual changeout of compressor seals. A statement of inclusion must accompany any quotations.

.4 If the compressor is not equipped with guide vanes for each stage and movable discharge diffusers, then furnish hot gas bypass and select chillers at 5% lower kW/ton than specified to compensate for bypass inefficiency at low loads.

.2 Lubrication System

.1 The compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. Coolers located inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement oil pump shall be powered through the unit control transformer.

.3 Refrigerant Evaporator and Condenser:

.1 The evaporator and condenser shall be single circuit and be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the Working pressure but not less than 100 psig. Provide intermediate tube supports at a maximum of 18 inch spacing.

.2 Tubes shall be enhanced for maximum heat transfer, rolled into steel tube sheets and sealed with Locktite or equal sealer. The tubes shall be individually replaceable and secured to the intermediate supports without rolling.

.3 Provide sufficient isolation valves and condenser volume to hold full refrigerant charge in the condenser during servicing or provide a separate pumpout system and storage tank sufficient to hold the charge of the largest unit being furnished.

.4 The water sides shall be designed for a minimum of 150 psig or as specified elsewhere. Vents and drains shall be provided.

.5 Chilled water minimum refrigerant temperature shall be 33 F.

.6 An electronic or thermal refrigerant expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have a moisture indicating sight glass.

.7 The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.

.8 Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.

.9 The evaporator, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

.10 Provide factory-mounted thermal dispersion flow switches on each vessel to prevent unit operation with no flow.

.4 Prime Mover:

.1 Squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified hereinafter. If the Contractor chooses to provided an open drive motor or compressor, verify in the submittal that the scheduled chiller room ventilation system will accommodate the additional heat and maintain the equipment room at design indoor temperature based on 95-degrees (F) outdoor ambient ventilation air available.

.2 If additional cooling is required, manufacturer shall be responsible for the installation, wiring and controls of a cooling system. Chiller selection shall compensate for tonnage and efficiency loss to make certain The City is not penalized.

.5 Variable Frequency Drive: The chiller shall be equipped with a Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and compressor pressure lift. The chiller control shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

.1 A digital regulator shall provide V/Hz control.

.2 The VFD shall have 110% continuous overload of continuous amp rating with no time limit, PWM (pulse width modulated) output, IGBT (insulated gate bipolar transistors) power technology, and full power rating at 2kHz.

.3 All heat producing devices shall be contained in a single heatsink with single inlet and out connections for the connection of chilled water. When factory mounted on the chiller package, the water connections shall be piped and leak tested at the factory.

.4 Provide Harmonic Filter. Floor Mounted. Wired by Electrical as per manufacturers recommendations.

.6 Chiller Controller

.1 The chiller shall have distributed control consisting of a unit controller, a compressor controller and a 15-inch super VGA color touch screen for operator interface with the control system. The touch screen shall have graphics clearly depicting the chiller status, operating data, including water temperatures, percent RLA, water setpoint, alarm status and have STOP and AUTO control buttons. The operator interface touch screen shall have inherent trend logging capabilities, which are transferable to other PC management systems such as an Excel spreadsheet via a USB port. Active trend logging data shall be available for viewing in 20 minute, 2 hour or 8 hour intervals. A full 24 hours of history is downloadable via a USB port. The following trended parameters shall be displayed:

.1 Entering and leaving chilled water temps
.2 Entering and leaving condenser water temps
.3 Evaporator saturated refrigerant pressure
.4 Condenser saturated refrigerant pressure
.5 Net oil pressure
.6 % rated load amps

.2 In addition to the trended items above, other real-time operating parameters are also shown on the touch screen. These items can be displayed in two ways: by chiller graphic showing each component or from a color-coded, bar chart format. Unit setpoints shall be viewable on screens and changeable after insertion of a password. Complete unit operating and maintenance instructions shall be viewable on the touch screen and be downloadable via an onboard USB port. At a minimum, the following critical areas must be monitored:

.1 Oil sump temperature
.2 Oil feed line temperature
.3 Evaporator saturated refrigerant temperature
.4 Suction temperature
.5 Condenser saturated refrigerant temperature
.6 Discharge temperature
.7 Liquid line temperature

.3 Automatic corrective action to reduce unnecessary cycling shall be accomplished through pre-emptive control of low evaporator or high discharge pressure conditions to keep the unit operating through ancillary transient conditions.

.4 System specific, chiller plant architecture software shall be employed to display the chiller, piping, pumps and cooling tower. Chiller plant optimization software for up to 3 chillers shall also be included to provide automatic control of: evaporator and condenser pumps (primary and standby), up to 4 stages of

cooling tower fans and a cooling tower modulating bypass valve and/or cooling tower fan variable frequency drives. There shall be five possible tower control strategies:

.1 Tower fan staging only – up to 4 stages controlled by either the entering condenser water temperature or lift differential temperature between the condenser and evaporator saturated temperatures.

.2 Tower fan staging plus low limit - controlled as in # 1 plus tower bypass valve set at a minimum entering condenser water temperature

.3 Tower staging with staged bypass control – similar to # 2 with additional control of the bypass valve between fan staging to smooth control and minimize fan staging.

.4 VFD staging only – in this mode, a variable speed drive controls the first fan with up to 3 more fans to be staged on and off and there is no bypass valve.

.5 VFD and Valve Staging – same as # 4 plus bypass valve control

.5 Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARKS® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier:

.1 BACnet MS/TP master (Clause 9)

.2 BACnet IP, (Annex J)

.3 BACnet ISO 8802-3, (Ethernet)

.4 LONMARKS FTT-10A. The unit controller shall be LONMARKS® certified.

.6 The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list. eXternal Interface File (XIF) shall be provided with the chiller submittal data. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

.5 Miscellaneous Items

.1 Vacuum Prevention System (negative pressure chillers only): Chiller manufacturer shall supply and install a vacuum prevention system for each chiller. The system shall constantly maintain 0.05 psig inside the vessel during non-operational periods. The system shall consist of a precision pressure controller, two silicon blanket heaters, a pressure transducer, and solid-state safety circuit.

.2 Refrigerant Detection Device (negative pressure chillers only): Chiller manufacturer shall supply and install a refrigerant detection device and alarm capable of monitoring refrigerant at a level of 10 ppm. Due to the critical nature of this device and possible The City liability, the chiller

manufacturer shall guarantee and maintain the detection monitor for five years after The City acceptance of the system.

.3 Waffle type vibration pads for field mounting under unit feet.

.4 Pumpout System: The unit shall be equipped with a pumpout system complete with a transfer pump, condensing unit, and storage vessel constructed according to ASME Code for Unfired Pressure Vessels and shall bear the National Board stamp. If the design of the unit allows the charge to be transferred to and isolated in the main condenser, then a pumpout system is not required. Transfer of refrigerant charge shall be accomplished by either main compressor operation, migration, or gravity flow. Isolation shall be accomplished with valves located at the inlet and outlet of the condenser. The main condenser shall be sized to contain the refrigerant charge at 90-degrees (F) according to ANSI-ASHRAE 15.A.

.5 Purge System (Negative Pressure Chillers Only): 1. The chiller manufacturer shall provide a separate high efficiency purge system that operates independently of the unit and can be operated while the unit is off. The system shall consist of an air-cooled condensing unit, purge condensing tank, pumpout compressor and control system.2. A dedicated condensing unit shall be provided with the purge system to provide a cooling source whether or not the chiller is running. The condensing unit shall provide a low purge coil temperature to result in a maximum loss of 0.1 pounds of refrigerant per pound of purged air.3. The purge tank shall consist of a cooling coil, filter-drier cores, water separation tube, sight glass, drain, and air discharge port. Air and water are separated from the refrigerant vapor and accumulated in the purge tank.4. The pumpout system shall consist of a small compressor and a restriction device located at the pumpout compressor suction connection.5. The purge unit shall be connected to a 100% reclaim device.

2.13 COOLING TOWER

.1 Provide an induced draft, crossflow type, factory assembled, film fill, industrial duty, galvanized steel cooling tower situated as shown on the plans. The limiting overall dimensions of the tower shall be 18.17 ft wide, 8.4 ft long, and 11.939 ft high. Total operating horsepower of all fans shall not exceed 14.751 Hp, consisting of 1 @ 15 Hp motor(s). Tower shall be similar and equal in all respects to Marley Model NC8403PAN1.

.2 Thermal Performance:

.1 The tower shall be capable of cooling 1050 gpm of water from 95 °F to 85 °F at a design entering air wet-bulb temperature of 75 °F, and its thermal rating shall be Certified by the Cooling Technology Institute.

.2 The tower shall be capable of a minimum 76.112 GPM/hp efficiency per ASHRAE Standard 90.1.

.3 Performance Warranty:

.1 CTI Certification notwithstanding, the cooling tower manufacturer shall guarantee that the tower supplied will meet the specified performance conditions when the tower is installed according to plan. If, because of a suspected thermal performance deficiency, The City chooses to conduct an on-site thermal performance test under the supervision of a qualified, disinterested third party in accordance with CTI or ASME standards during the first year of operation; and if

the tower fails to perform within the limits of test tolerance; then the cooling tower manufacturer will pay for the cost of the test and will make such corrections as are appropriate and agreeable to The City to compensate for the performance deficiency.

.4 **Warranty:**

.1 **The cooling tower manufacturer's warranty shall be for a period of two (2) years from date of equipment start up. The warranty shall include parts and labor costs for the repair or replacement of defects in Material or Workmanship.**

.5 **Service Package**

.1 Include a 2-year Service package, to include seasonal start-up, mid-season check and seasonal shut-down.

.6 Design Loading

.1 The tower structure, anchorage and all its components shall be designed by licensed structural engineers per the International Building Code to withstand a wind load of 30 psf, as well as a .3g seismic load. The fan deck and hot water basin covers shall be designed for 50 psf live load or a 200 lb. concentrated load. Guardrails, where specified, shall be capable of withstanding a 200 lb. concentrated live load in any direction, and shall be designed in accordance with OSHA guidelines.

.1 The tower shall be structurally capable of being supported at the four outer corners of the tower cell. Alternatively, the tower manufacturer shall provide supporting steel to adapt tower to be supported at four outer corners.

.7 Construction:

.1 Except where otherwise specified, all components of the cooling tower shall be fabricated of heavy-gauge steel, protected against corrosion by G-235 galvanizing. The tower shall be capable of withstanding water having a pH of 6.5 to 8.0; a chloride content (NaCl) up to 300 ppm; a sulfate content (SO4) up to 250 ppm; a calcium content (CaCO3) up to 500 ppm; silica (SiO2) up to 150 ppm; and design hot water temperatures up to 125°F. The circulating water shall contain no oil, grease, fatty acids or organic solvents.

.2 Fiberglass casing, polyurethane barriers, and thermosetting hybrids and the components they are adhered to shall be considered non-recyclable and not allowed.

.3 The Specifications, as written, are intended to indicate those Materials that will be capable of withstanding the above water quality in continuing service, as well as the loads described in paragraph 4.1. They are to be regarded as minimum requirements. Where component Materials peculiar to individual tower designs are not specified, the manufacturers shall take the above water quality and load carrying capabilities into account in the selection of their Materials of manufacture.

.4 The tower shall include all design and material modifications necessary to meet the requirements of Factory Mutual. The product proposed shall be listed in the FM Approval Guide, latest edition.

.8 Mechanical Equipment:

.1 Fan(s) shall be propeller-type, incorporating wide-chord aluminum alloy blades and galvanized hubs. Blades shall be individually adjustable. Maximum fan tip speed shall be 13,000 ft/min. Fan(s) shall be driven through a right angle, industrial duty, oil lubricated, geared speed reducer that requires no oil changes

for the first five (5) years of operation. The gearbox bearings shall be rated at an L10A service life of 100,000 hours or greater.

.1 An external oil level dipstick shall be located adjacent to the motor at the fan deck surface and shall be accessible from a portable maintenance ladder.

.2 The motor shall be mounted outside the casing of the tower, and shall be connected to the gear reducer by a dynamically-balanced, stainless steel tube and flange driveshaft.

.2 Motor(s) shall be 15 Hp maximum, TEFC, 1.15 service factor, variable torque, and specially insulated for cooling tower duty. Speed and electrical characteristics shall be 1800 rpm, single-winding, 3 phase, 60 Hz, 575 volts. Motor shall operate in the shaft-horizontal position, and nameplate horsepower shall not be exceeded at design operation.

.3 The complete mechanical equipment assembly for each cell shall be supported by a rigid steel structural support that resists misalignment between the motor and the gear reducer. The mechanical equipment assembly shall be warranted against any failure caused by defects in Materials and Workmanship for no less than five (5) years following the date of tower shipment. This warranty shall cover the fan, speed reducer, drive shaft and couplings, and the mechanical equipment support. The electric motor shall carry a manufacturer's warranty of at least one year.

.4 A Marley/ABB ACH550 complete UL listed Variable Speed Drive system in NEMA 12 indoor enclosure shall be provided. The VFD shall use PWM technology with IGBT switching. VFD output switching signal shall be programmed to not cause mechanical vibration issues with backlash in gearbox teeth or vibration issues associated with long driveshafts. The VFD shall be programmed for variable torque applications and shall catch a fan spinning in the forward or reverse direction without tripping. VFD panel construction shall include a main disconnect with short circuit and thermal overload protection with external operating handle, lockable in the off position for lock-out tag-out safety procedures. A service switch directly ahead of the VFD shall be provided for voltage isolation during VFD maintenance. An integrated full voltage non-reversing bypass starter shall be furnished allowing fan motor operation if VFD has failed. The VFD system shall receive a speed reference signal from the building management system monitoring the tower cold-water temperature. As an option to receiving the speed reference signal from a building management system, the drive must have the capability to receive a 4-20 mA temperature signal from an RTD transmitter. The VFD shall have an internal PI regulator to modulate fan speed maintaining set point temperature. The drive's panel shall display the set-point temperature and cold-water temperature on two separate lines. The bypass shall include a complete magnetic bypass circuit with the capability to isolate the VFD when in the bypass mode. Transfer to the bypass mode shall be manual in the event of VFD failure. Once the motor is transferred to the bypass circuit the fan motor will run at constant full speed. Operator controls shall be mounted on the front of the enclosure and shall consist of Start and Stop control, Bypass/VFD selection, Auto/Manual selections and manual speed control. To prevent heating problems in the cooling tower fan motor the VFD system shall de-energize the motor once 25% motor speed is reached and cooling is no longer required. The cooling tower manufacturer shall supply VFD start-up assistance and vibration testing throughout the speed range to identify and lockout any natural frequency vibration levels which may exceed CTI guidelines. Include VFD output filter, NEMA 1 575V/3/60.

.5 A vibration limit switch in a NEMA 4 housing shall be installed on the mechanical equipment support and wired to the shutdown circuit of the fan motor starter or VFD. The purpose of this switch will be to interrupt control power voltage to a safety circuit in the event of excessive vibration causing the starter or VFD equipment to de-energize the motor. It shall be adjustable for sensitivity, and include a means to reset the switch.

.9 Fill, Louvers and Drift Eliminators:

.1 Fill shall be film type, thermoformed of 15 mil thick PVC, with louvers and eliminators formed as part of each fill sheet. Fill shall be suspended from hot dip galvanized structural tubing supported from the tower structure, and shall be elevated above the floor of the cold water basin to facilitate cleaning. Air inlet faces of the tower shall be free of water splash-out. Fill shall be capable of withstanding a hot water temperature of 125°F.

.2 Drift eliminators shall be PVC, triple-pass, and shall limit drift losses to 0.005% or less of the design water flow rate.

.10 Hot Water Distribution System:

.1 Two open galvanized steel basins (one above each bank of fill) shall receive hot water piped to each cell of the tower. These basins shall be installed and sealed at the factory, and shall be equipped with removable, galvanized steel covers capable of withstanding the loads described in paragraph 4.1. The water distribution system shall be accessible and maintainable during tower fan and water operation.

.2 Heavy-duty flow-regulator valves shall be provided at the hot water inlet connections. These valves shall be disc-type, with cast iron bodies and stainless steel operating stems. There shall be a locking handle to maintain the valve setting in any position. Valves shall be right-angle configuration, precluding the need for inlet elbows.

.3 The water distribution system shall be accessible and maintainable while tower is operating.

.11 Casing, Fan Deck and Fan Guard:

.1 The casing and fan deck shall be galvanized steel, and shall be capable of withstanding the loads described in paragraph 4.1. The top of the fan opening shall be equipped with a conical, non-sagging, removable fan guard, fabricated of welded 5/16" and 7 gauge rods, and hot dip galvanized after fabrication. Fan cylinders 5'-0" in height and over shall not be required to have a fan guard.

.12 Access:

.1 A large galvanized, rectangular access door shall be located on both cased faces for entry into the cold-water basin. Doors shall provide convenient access to the fan plenum area to facilitate inspection and allow maintenance to the fan drive system. The access doors shall be at least 30" wide by 33" high.

.2 The top of the tower shall be equipped with a sturdy guardrail, complete with kneerail and toeboard, designed according to OSHA guidelines and factory welded into subassemblies for ease of field installation. Posts, toprails and kneerails shall be 1.5 " square tubing. The guardrail assembly shall be hot dipped galvanized after welding and capable of withstanding a 200 pound concentrated live load in any direction. Posts shall be spaced on centers of 8'-0" or less. A 1'-6" wide aluminum ladder with 3" I-beam side rails and 1.25" diameter rungs shall be permanently attached to the endwall casing of the tower, rising from the base of the tower to the top of the guardrail.

.1 Provide a ladder extension for connection to the foot of the ladder attached to the tower casing. This extension shall be long enough to rise from the roof (grade) level to the base of the tower. The installing Contractor shall be responsible for cutting the ladder to length; attaching it to the foot of the tower ladder; and anchoring it at its base.

.3 Ladder Safety

.1 A heavy gauge aluminum safety cage, welded into subassemblies for ease of field installation, shall surround the ladder, extending from a point approximately 7'-0" above the foot of the ladder to the top of the guardrail. Maximum weight of welded subassemblies shall not exceed 20 lb for ease of installation

.4 There shall be an access platform at the base of the tower extending from the vertical ladder to the access door. The platform shall be surrounded by an OSHA compliant guardrail system welded into subassemblies for ease of installation. The walking surface of the platform shall be perforated to provide a non-slip surface for personnel safety.

.5 Provide a factory-installed, walkway extending from one cased-face access door to the other cased face. A steel framework shall support the walkway and the top of the walkway shall be at or above the cold-water basin overflow level. The walkway and framework to be equivalent material as the tower basin and have a minimum width of 36".

.13 Cold Water Collection Basin:

.1 The collection basin shall be G-235 galvanized steel and assembled with bolted connections. Tap screws shall not be allowed. The basins shall include the number and type of suction connections required to accommodate the outflow piping system shown on the plans. Suction connections shall be equipped with debris screens. A factory installed, float operated, mechanical make-up valve shall be included. An overflow and drain connection shall be provided in each cell of the cooling tower. The basin floor shall slope toward the drain to allow complete flush out of debris and silt that may accumulate. Towers of more than one cell shall include a method for flow and equalization between cells. The basin shall be accessible and maintainable while water is circulating.

.2 Provide a system of electric immersion heaters and controls for each cell of the tower to prevent freezing of water in the collection basin during periods of shutdown. The system shall consist of 15KW, 575/3/60 stainless steel electric immersion heaters installed in threaded couplings provided in the side of the basin. A NEMA 4 enclosure shall house a magnetic contactor to energize heaters; a transformer to provide 24-volt control circuit power; and a solid-state circuit board for temperature and low water cut-off. A control probe shall be located in the basin to monitor water level and temperature. The system shall be capable of maintaining 40°F water temperature at an ambient air temperature of -21 °F.

Part 3 Execution

3.1 PIPE AND FITTINGS

.1 Inside of all pipe, fittings, traps, valves and all other equipment to be smooth, clean and free from blisters, loose mill scale, sand and dirt when erected.

.2 Install screwed unions or flanges at all equipment connections, elements, traps, valves, etc.

.3 Pipe bending is not permitted.

.4 Pipe and fittings up to and including 50mm (2") diam. to be screw jointed with screwed fittings. Make screw joints iron to iron, with graphite and oil filler or joint compound. Dope male threads only. All fuel oil piping shall be welded.

.5 Pipe and fittings 63mm (2-1/2") diam. and above to be jointed by welding. Branch connections to be welded using butt welding fittings. Use slip-on welding flanges, welded to pipe on which they are fitting, at flange neck and back-welded on pipe end, at inside flange face. Valve companion flanges to be flat or raised face, matching valve flange. Use gaskets on flanged joints.

.6 Branch connections of sizes 13mm (1/2"), 19mm (3/4") and 25mm (1") for radiation may be formed on mains of 50mm (2") diam. and above using carbon steel Thred-O-Let welding fittings.

.7 Branch connections of sizes 31mm (1-1/4"), and larger to be formed using Weld-O-Lets. Reductions in mains to be after branches using butt weld reducing fittings. Site or shop fabricated welding fittings not permitted.

.8 Welding to conform to Provincial Department of Labour Regulations. Welders to be licensed.

.9 Use long radius elbows. For pipe reductions use eccentric reducing sockets.

.10 Keep pipe connections clear for tube removal, etc.

.11 Dielectric Couplings
- .1 Provide where pipes of dissimilar metals are joined.
- .2 Provide unions or flanges for pipe 50mm (2") and smaller and flanges on piping 63mm (2-1/2") and larger.
- .3 Use Style 47 Dielectric Waterway as manufactured by Victaulic.

.12 Branch Connections
- .1 Type 'K' copper soft temper pipe - Silver braze joints using Handy & Harman's silver brazing alloy and flux. Fittings to Emco smooth bore silver braze fittings.

3.2 VICTAULIC PIPING

.1 Prior to coupling assembly, lightly coat lips and outer surface of gasket with a non-toxic (Vic-Lube) lubricant as recommended by manufacturer. Pipes shall be gapped at time of installation to allow for expansion and Contraction of system where required.

3.3 PIPING SYSTEMS

.1 Steam and Condensate
- .1 Grade mains down in direction of flow 1:240. Counter grade steam mains only where noted.
- .2 Supply branches such as swing pieces, offsets in risers, runout to radiation and the like which drain against steam flow, to be one size larger pipe than pipes they supply. Provide swing connections and grade 6mm/25mm (1/4" per foot).
- .3 Use full size scale pockets ahead of steam traps.

.2 Water Piping Systems
- .1 Grade up in flow direction or as noted so air may pass through connecting risers, etc. Minimum grading to be 1:480.

.3 General

.1 Install branch riser take-offs to grade up to riser.
.2 Run piping parallel to walls and as unobtrusive as possible when viewed from inside or outside building.
.3 Where pipe change in direction is shown to take up expansion, spring piping cold.
.4 Blow out radiation and coils with compressed air prior to piping connections.
.5 Use welded piping in concealed areas and as a result inaccessible, i.e. plastered ceilings, etc. Control valves, etc. to be accessible through access doors.
.6 Install drain cocks at system low points. Pipe to nearest floor drain.

3.4 TESTING OF SYSTEMS

.1 Tests to be carried out in accordance with following time-pressure requirements and regulations and requirements of authorities have jurisdiction.

.2
.1 Steam & Condensate - 0 to 29 psig - test at 100 psig for 12 hrs.

.3 Chilled water - test at 862 kPa (125 psig), or to pressure 1-1/2 times operating pressure, which ever is greatest, for 12 hrs.

.4 Condenser water - test at 862 kPa (125 psig), or to pressure 1-1/2 times operating pressure, which ever is greatest, for 12 hrs.

.5 Piping, concealed prior to completion of total service, to be tested in sections prior to concealment. Tests to be witnessed by Contract Administrator's representative. Two Working days prior notice to be given Contract Administrator of such tests. Pressures to be as registered at system highest point. When sections are being tested additional pressure developed by static head of remainder of system above, to be added to specified test pressure.

.6 Tests to be with water, unless noted otherwise, prior to insulation being applied.

.7 System tests to be with equipment connected. Trap diaphragms to be removed and systems flushed prior test.

.8 Make good leaks, replace defective parts, flush out defective section, re-test and adjust until system functions correctly.

.9 Prior to The City's takeover, systems to be balanced and ready for operation, with traps, strainers, drip legs, etc. cleaned.

3.5 VALVES

.1 Provide three valve by-passes in the following locations and where shown on Drawings. By-pass valves shall be as specified for balancing valves.
.1 Pressure reducing valves.
.2 Temp. control valves on heating coils where the inlet air temperatures are 5 deg. C and below.

.2 Provide isolating valves in the following locations and where shown on Drawings.
.1 Suction and discharge of pumps.
.2 Before all temp. control valves.
.3 Before all steam traps:
.4 On discharge from all steam traps where system pressure is above 103 kPa (15 psig).
.5 Inlet and outlet of all water and steam fed equipment.

.1 Inlet valve shall be ahead of control valve to single coils. Provide inlet and outlet valves on all coil sections in multiple coil bank.

.2 Where piping detail sheets note balancing valves on leaving side of radiation and coils, additional outlet isolating valves not required, unless specifically noted on detail sheet.

.3 Provide balancing valves in following locations and where noted.

.1 Pump discharges.

.4

.1 Valves on all steam and water systems shall be gate type valves except for radiator valves and bypass valves which shall be globe type.

.5 Provide chain wheel operators c/w chain for all valves where the valve operator is higher than 6'-6" above the floor. Where necessary provide shaft extensions c/w brackets and bearing to locate chain wheel operator in accessible location.

.6 Provide a union or flange dependent on size of piping between butterfly valves and equipment which they serve to permit isolation and removal of equipment.

.7 Butterfly valves shall be considered equal to gate valves for chilled water and condenser water installations.

.8 Ball valves shall be considered equal to gate valves for low pressure condensate, chilled water and condenser water installations.

3.6 EXPANSION JOINTS

.1 Use guides on each side of expansion joints and compensators. Support from structural brackets.

.2 When expansion joints are installed at ambient temps. higher than minimum system operating temp. they shall be precompressed prior to installation, to allow for eventual Contraction of piping.

3.7 FLEXIBLE PIPE CONNECTIONS

.1 Install as per manufacturer's recommendations.

.2 Provide spring hangers for first three pipe support points from flexible connections.

3.8 ANCHORS

.1 Fit anchors on vertical piping to ensure that water or air is not trapped. Fabricate from channels and angles to suit location; brace to building structure.

3.9 AIR VENTS

.1 Install automatic float air vent at system high points, where air may be trapped in chilled water systems, and where noted, to suit operating pressures. Pipe discharges to nearest plumbing drain. Provide isolating valves ahead of auto air vents except at coils having service valves.

3.10 STRAINERS

.1 Provide pipe strainers in following locations and where shown on Drawings.

.1 Before all steam traps, except at steam traps where strainer is provided in steam pipe serving equipment on which trap is installed. Refer to Specifications for requirements.
.2 Before all steam temp. regulating valves.
.3 Pressure reducing valves.
.4 Pump suctions.

3.11 STEAM TRAPS

.1 Provide steam traps where noted and in following locations.
.1 On all steam fed equipment.
.2 At base of all steam riser pipes.

.2 Provide union at each steam trap for servicing.

.3 Provide globe valve by-pass at steam traps where noted.

.4 Provide double trapping assemblies on all preheat coils and on all heating coils where air inlet temperature is below plus 5 deg. C. Double trapping assemblies shall have isolating valve before each trap for servicing.

3.12 VACUUM BREAKERS

.1 Provide vacuum breakers in following locations and where noted.
.1 Steam piping to all steam preheat coils and all steam heating coils where the air inlet temp. is below plus 5 deg. C.

.2 Locate vacuum breaker on piping between steam control valve and inlet connection to coil, tank or heat exchanger.

.3 Vacuum breaker shall comprise of 19mm (3/4") swing type check valve piped to within 150mm (6") of floor.

3.13 THERMOMETERS

.1 Stems and wells to be immersed in liquid flow. Where a separable well is mounted in pipe 37mm (1-1/2") diam. or less, enlarge pipe to 50mm (2") diam. for well length plus 75mm (3").

3.14 PRESSURE GAUGES

.1 Use pressure gauges on pressure reducing valve stations, suctions and discharges of pumps and where noted.

.2 Gauges, subject to vibration, to have copper tube extensions to locate away from source of vibration.

3.15 STEAM AND CONDENSATE PIPING CLEANOUT

.1 General
.1 Cleanout new steam and condensate piping.
.2 Remove valves and strainers from system before cleanout.
.3 If any system is to be used for temporary heat, clean as outlined herein prior to use for temporary heat and then cleaned again before takeover by The City.

.2 Steam and Condensate Piping Cleanout
.1 Operate all steam and condensate systems for minimum of two days with all condensate wasted to drain.

.2 After two day period, clean all strainers and pumped condensate line connected to receiver.

3.16 VIBRATION CONTROL

.1 Supply Drawings of all equipment to be isolated to isolation manufacturer. Manufacturer to submit approval Drawings with isolation equipment schedule.

.2 Manufacturer's factory-trained representative to inspect finished job and issue report to Contract Administrator indicating that all isolation equipment has been installed as per manufacturer's recommendations.

3.17 CO-ORDINATE WITH HVAC BALANCE AND TESTING AGENCY

.1 Refer to Section 15990 HVAC Balance and Testing.

.2 Air balancing Work shall not begin until system has been completed and in full Working order. Section 15600 shall put all heating, ventilation, and air conditioning systems and equipment into full operation, as season would demand, and shall continue operation of same during each Working day of testing and balancing. Co-ordinate Work with Section 15990.

.3 As part of this Contract, Section 15600 shall make any changes in pulleys and belts, and add manual dampers for correct balance as recommended by Section 15990, at no additional cost to The City.

.4 Section 15600 responsible for initial alignment and tension of all fan pulleys and belts of equipment supplied by Section 15600.

3.18 PACKAGED AIR HANDLING UNITS

.1 Start-up of unit shall be executed by manufacturer's personnel. A complete manufacturer's check list of field start-up tests must be submitted with operations and maintenance instructions, and shall be signed by start-up technician and mechanical trade, field supervisor as certified satisfactory for operation.

.2 Complete AHU factory installation relating to mechanical and or electrical Materials, piping, pipe insulation, wiring etc. shall conform to standards set out in Division 15 and Division 16 Specification.

.3 AHU's shall be CSA labelled and shall conform to Canadian Electrical Code and all Manitoba Codes.

3.19 CHILLER

.1 Installation
- .1 Install in strict accordance with manufacturer’s requirements, Shop Drawings, and Contract Documents.
- .2 Adjust chiller alignment on concrete foundations, sole plates or subbases as called for on Drawings.
- .3 Arrange the piping on each vessel to allow for dismantling the pipe to permit head removal and tube cleaning.
- .4 Furnish and install necessary auxiliary water piping for oil cooler
- .5 Coordinate electrical installation with electrical Contractor.
- .6 Coordinate controls with control Contractor.
- .7 Provide all Material required to ensure a fully operational and functional chiller.

.2 Start-Up

.1 Ensure proper charge of refrigerant and oil.

.2 Factory Start-Up Services: The manufacturer shall provide factory authorized supervision for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full Working days. During the period of start-up, the start-up technician shall instruct The City's representative in proper care and operation of the unit.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

.1 Labour, Materials, plant, tools, equipment and services necessary and reasonably incidental to completion of air conditioning and/or ventilation Work.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 15010 Mechanical General Provisions

.2 Section 15180 Insulation

.3 Section 15400 Plumbing

.4 Section 15600 Liquid Heat Transfer

.5 Section 15900 Controls/Instrumentation

.6 Section 15990 Testing, Adjusting and Balancing

.7 Section 16010 Electrical General Provisions

Part 2 Products

2.1 DUCT AND EQUIPMENT SUPPORTS, HANGERS AND INSERTS

.1 Support horizontal ducts on maximum 2.4m (8'0") centres by non perforated galv. steel, rivetted strap for ductwork 900mm (36") (either dimension) or less, and minimum 25mm x 25mm x 3mm (1" x 1" x 1/8") galv. angle iron passing under ducts 925mm (37") or over (either dimension) with 9.4mm (3/8") diam. threaded rods suspending angles from structure.

.2 Support vertical ducts at every floor with angle iron collars sized to provide proper bearing.

.3 Use universal concrete type inserts of black malleable iron, for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

2.2 LOW PRESSURE DUCTWORK

.1 Low Pressure Rectangular Ductwork Schedule

	Max. Side	Bracing
.1	Up to 600mm (24”) .1 Gauge: .60mm (24 USSG)	None
.2	635mm to 750mm (25" to 30") .1 Gauge: .60mm (24 USSG)	25mm (1") x 25mm (1") x 3.2mm (1/8") angle, 1.2mm (4'0") from joint.
.3	785mm to 1000mm	25mm (1") x 25mm (1") x 3.2mm (1/8") angle,

Max. Side		Bracing
	(31" to 40")	1.2mm (4'0") from joint.
	.1 Gauge: .80mm (22 USSG)	
.4	1040mm to 1.5m (41" to 60")	37.5mm (1-1/2") x 37.5 (1-1/2") x 3.2mm (1/8") angle, 1.2m (4'0") from joint.
	.1 Gauge: .80mm (22 USSG)	

.2 Ductwork to be galvanized steel unless noted otherwise.

.3 Outdoor ductwork to be two gauges heavier than directed above.

.4 Turning vanes (Ducturns)
- .1 Use duct elbows which have throat radius of 1-1/2" times the diameter.
- .2 Where use of above specified item is precluded by space limitations, use duct elbows fabricated square throats and backs and fitted with Rovane turning vanes.
- .3 Standard of Acceptance: S.E. Rozell & Sons Limited, Kitchener, Ontario.

2.3 MOTORIZED DAMPERS

.1 Supplied by Section 15900 for installation by Section 15800:

2.4 DUCT ACCESS DOORS

.1 Install airtight, 25mm (1") internal glassfiber insulated access doors in ductwork as noted and at all humidifier dispersion tubes, motorized dampers; at inlet and outlet of vaneaxial and axial fans; at inlet of heating coils; at fire dampers and locations noted on Drawings.

.2 Access doors at fire dampers, fire/smoke dampers and smoke detectors shall be minimum 300mm (12") x 300mm (12") or larger to fully access and replace fusible link. Enlarge duct as required.

2.5 FILTERS

.1 General:
- .1 Fan manufacturer to provide filter in filter sections provided with equipment.
- .2 Filter supplier to provide all other filters.
- .3 Provide one spare set of filter media for each filter bank.
- .4 Section 15800 shall fabricate filter sections not provided with equipment. Provide access panels c/w cam-lock fasteners, on each side of filter section. Access doors shall also have gaskets that butt against the filter frames to eliminate bypassing of air filters. Filter banks exposed to the outdoors shall have stainless steel piano hinges.

.2
- .1 Unless noted otherwise, all fan systems to have AAF Frontline Red replaceable media filters of 47mm (1-7/8") thick fibreglass pads coated with Viscosine. Media housed in AAF Renu Filter Frame, and shall be c/w catch mechanism as required. Media shall have 85% average synthetic dust weight arrestance based on ASHRAE 52-76 Test Method.

2.6 FAN SYSTEMS - GENERAL

.1 Fan Connections

.1 Duro-Dyne Metal-Fab of neoprene coated fibreglass, airtight, water tight and flameproof, 75mm (3") wide with 75mm (3") galv. metal connections.

.2 V-Belt Fan Drives

.1 Provide multi-matched set of belts for all fans with motors of 1.12 kW (1-1/2 hp) and larger.

.2 Provide vari-speed adjustable drive on units with motors of 7.46 kW (10 hp) and less. Drive to allow speed variation of plus or minus 15% of fan speed at specified capacity. Should this variation not be attainable, manufacturer to provide extra fixed pulley and if necessary, matched belts to provide this speed range, if requested by Contract Administrator.

.3 Provide fixed pitch on units with motors of 7.46 kW (10 hp) and greater. Manufacturer shall include for one change in drive; i.e. allow for additional pulley and matched belts for each air handling unit.

.4 Fans mounted outside of building to have belt drives capable of operating satisfactorily at -37 deg.C ambient.

.5

.1 Vari-pitch type with multi-belt matched set of belts with factor of 1.3 against motor nameplate rating.

.2 Drive shall allow speed variation of +/- 15% of fan speed at specified capacity.

.3 Fan Bearings

.1 Fan bearings shall be selected to have minimum B10 life of 15,000 hours or minimum average life of 75,000 hours.

.2 All grease lubricated bearings that are not directly accessible shall be fitted with extended grease leads terminating at some convenient accessible location on the fan casing.

.4 Fan Vibration Isolation

.1 Selected and supplied by isolation manufacturer.

.5 Fan Vibration Isolators

.1 Spring vibration isolators designed and selected to operate at no greater than 2/3 solid deflection and be stable for lateral displacements. Spring mounts c/w levelling device and rubber sound pads. For loads less than 227 kg (500 lbs.) and deflection l less than 31mm (1.2"), use Vibro Acoustics CM cast type mount. For loads and deflections greater than this, Vibro-Acoustics type FS open type mounts shall be used.

.2 Unless noted otherwise, mount floor mounted air handling units upon CM spring mounts to give 25mm (1") static deflection.

.3 Hang all suspended fans with SH-1 spring hangers to provide 25mm (1") static deflection.

.6 Scheduled operating fan speeds and outlet velocities noted in Specification herein and/or in fan schedules shall be maximum acceptable.

.7 Guards

.1 Protect V-belt drives by guards that encompass all sides of the drive. Any expanded mesh or ventilation openings in the guard are to be "finger proof" to meet OSHA requirements.

.2 Mount guards to the fan by bolted clips. They shall be completely removable.

.3 Each guard shall be c/w two 25mm diameter holes opposite both fan and motor shaft for purpose of allowing tachometer readings. Each hole will be covered with gravity-actuated swing cap.

.4 Front face of drive guard shall be hinged and latched for convenient access to interior.

.8 Refer to Fan Schedule for fan sizes, capacities, etc.

2.7 DIFFUSERS, REGISTERS AND GRILLES

.1 Steel diffusers to have baked enamel finish, unless noted otherwise herein. Aluminum grilles and registers to be of welded construction and to have etched finish with clear lacquer overcoat unless noted otherwise herein.

.2 Grilles and registers to be of one-piece construction with hidden mullions.

.3 Sidewall Supply Single Deflection Register - E.H. Price 510D/F/L/A/B12 c/w integral steel damper. 1-1/4" type F flat border style with front blades @ 3/4" O.C. parallel to long dimension. Type A counter sunk screwholes with oval-head screw fastening. Steel construction. B12 white standard finish.

2.8 BELT DRIVEN CENTRIFUGAL INLINE FAN

.1 Submittals

.1 General: Submit in accordance with Section 15010 1.9 Mechanical Shop Drawings, and Section 15051 Acceptable Materials and Equipment.

.2 Provide dimensional Drawings and product data on each fan

.3 Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted

.4 Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones

.5 Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.04 of this Specification

.6 Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance

.7 Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams

.2 Quality Assurance

.1 Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance seal

.2 Classification for Spark Resistant Construction Conform to AMCA 99

.3 Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3)

.4 Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories

.5 The High Wind models shall be analyzed and stamped by a state license P.E. to the ASCE 7-02 Standard which meets the IBC, Florida and Miami-Dade codes
.6 Each High Wind model is subject to be certified by a third party to the ASTM E330 Static Pressure Difference Standard
.7 All High Wind models shall be analyzed using Computational Fluid Dynamics (CFD). The CFD simulates the flow of high speed (150MPH) winds over the surface of objects
.8 The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads

.3 Delivery, Storage, And Handling
.1 Delivery: Deliver Materials to Site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, Material, products included, and location of installation
.2 Storage: Store Materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual
.3 Handling: Handle and lift fans in accordance with the manufacturer’s instructions. Protect Materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer

.4 Warranty
.1 Manufacturer's Warranty: Submit, for The City's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights The City may have under Contract Documents
.2 The warranty of this equipment is to be free from defects in Material and Workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid
.3 Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station

.5 Maintenance
.1 Refer to Manufacturer's Installation, Operation and Maintenance Manual (IOM), to find maintenance procedures

.6 General Description:
.1 Base fan performance at standard conditions (density 0.075 Lb/ft3)
.2 Performance capabilities up to 28,000 cubic feet per minute (cfm) and static pressure to 4 inches of water gauge
.3 Fans are available in fourteen sizes with nominal wheel diameters ranging from 11 inches through 36 inches (70 - 420 unit sizes)
.4 Normal operating temperature up to 180 Fahrenheit (82.2 Celsius)
.5 Applications include: intake, exhaust, return, or make-up air systems
.6 Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number
.7 Wheel:
.1 Non-overloading, backward inclined centrifugal wheel
.2 Constructed of aluminum
.3 Statically and dynamically balanced in accordance to AMCA Standard 204-05

.4 The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
.5 Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone.

.8 Motors:
.1 Motor enclosures: Totally enclosed fan cooled
.2 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase

.9 Shafts and Bearings:
.1 Fan shaft shall be ground and polished solid steel with an anti corrosive coating
.2 Permanently sealed bearings or pillow block ball bearings
.3 Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
.4 Fan Shaft first critical speed is at least 25 percent over maximum operating speed

.10 Housing/Cabinet Construction
.1 Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
.2 Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
.3 Aluminum construction is available in sizes 70-300

.11 Housing Supports and Drive Frame:
.1 Housing supports are constructed of structural steel with formed flanges
.2 Drive frame is welded steel which supports the shaft and bearings and reinforcement for the housing
.3 Pivoting motor plate with adjusting screws to make belt tensioning operations

.12 Disconnect Switches:
.1 NEMA rated: 1
.2 Positive electrical shut-off
.3 Wired from fan motor to junction box installed within motor compartment

.13 Drive Assembly:
.1 Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
.2 Belts: Static free and oil resistant
.3 Pulleys: Cast type, keyed, and securely attached to wheel and motor shafts
.4 Motor pulleys are adjustable for final system balancing
.5 Readily accessible for maintenance

.14 Duct Collars:
.1 Square design to provide a large discharge area
.2 Inlet and discharge collars provide easy duct connection

.15 Access Panel:
.1 Two sided access panels, permit easy access to all internal components
.2 Located perpendicular to the motor mounting panel

.16 Options/Accessories:
.1 Belt Guards:

.1 Three-sided fabricated steel belt guard covers drive and motor

.2 Belt Type:
- .1 Type: [Standard] [Grip Notch]

.3 Finishes:
- .1 Coating type: Permatector

.4 Isolation:
- .1 Type: Spring Hanging
- .2 Sized to match the weight of each fan

.5 Motor Cover:
- .1 Constructed of galvanized steel
- .2 Covers motor and drives for safety
- .3 Standard on unit specified with UL

Part 3 Execution

3.1 DUCT AND EQUIPMENT SUPPORTS, HANGERS AND INSERTS

.1 Design, Installation
- .1 Supports to secure ducts and equipment, prevent vibration and provide for expansion and contraction. Design supports of strength and rigidity in a manner which will not stress the building construction. Use inserts for suspending hangers. Do not use vertical expansion shields without Contract Administrator's approval.

.2 Concrete Inserts
- .1 Do not weaken concrete or penetrate waterproofing membrane. Use reinforcing rods through inserts for pipe sizes over 50mm (2"), or equivalent weight. Where concrete slab is finished ceiling, inserts to be flush with surface.

.3 Protect insulation at contact with hangers and support with approved metal shields.

3.2 CO-ORDINATION WITH H.V.A.C. BALANCE AND TESTING AGENCY

.1 Refer to Section 15990 H.V.A.C. Balance and Testing. Co-ordinate Work with Section 15990.

.2 As a part of this Contract, Section 15800 shall make any changes in pulleys and belts, and add manual dampers for correct balance as recommended by 15990, at no additional cost to The City.

.3 Section 15800 responsible for initial alignment and tension of all fan pulleys and belts, of equipment supplied by Section 15800.

3.3 LOW PRESSURE DUCTWORK

.1 Where duct width exceeds 450mm (18") in largest dimension, stiffen by cross breaking sheets diagonally. Beaded ducts as per SMACNA Catalogue Fig. 1.13 acceptable alternative.

.2 Duct sizes are inside dimensions. If ducts are acoustically lined, outside duct size to be increased as required.

.3 Provide ducturns in all elbows of ducts 1200mm (48") wide and greater, in segments of 600mm (24") maximum.

.4 Single thickness partitions between ducts not accepted.

.5

.1 All ductwork shall have seams and joints sealed watertight with Duro-Dyne S-2 duct sealer and FT-2 fibreglass duct tape. Prior to installation ductwork to be clean, dry and free of grease. Apply duct sealer with stiff brush or trowel. Wrap wet seam or joint with duct tape and apply further coat of duct sealer. Duct sealer and glassfiber to extend 25mm (1") on each side of joint or seam. On outside ductwork construct duct so that top of duct slopes 12mm (1/2") per 300mm (12") minimum to ensure that water does not collect on top.

.2 Ductwork exposed in finished rooms do not require duct tape application, but seams and joints shall be sealed with S-2 duct sealer. Sealer must be capable of accepting finish painting.

.3 Ductwork on roof shall have seams and joints sealed by application of TREMCO MONO black acrylic sealant applied with application gun and levelled with putty knife. Material shall be used in accordance with manufacturer's printed recommendations.

.6 Provide openings for thermostats and controllers by Section 15900.

.7 Where ductwork conflicts with mechanical and electrical piping and it is not possible to divert ductwork or piping to stay within allowable space limitations, provide duct easements. Easements not required on pipes 100mm (4") and smaller outside dimension, unless this exceeds 20% duct area. Irregular or flat shaped piping requires duct easement. Hangers and stays in ductwork to be parallel to air flow. If easement exceeds 20% of duct area, duct to be split into two ducts with original duct area being maintained. Easements to be approved by Contract Administrator before installation.

.8 At points within air system where air streams at different temperatures meet, install baffling for a good mix. Baffling to be by Section 15800 in locations recommended by Section 15900, approved by Contract Administrator, and at no additional cost to The City.

.9 If ductwork is not adequately braced and/or supported to provide good installation, additional bracing and/or supports to be provided at no extra cost to The City. Contract Administrator to interpret.

.10 Assemble round duct sections using beaded couplings attached with sheet metal screws.

.11 Every intake and exhaust duct up through the roof shall be installed with a 2" (50mm) deep water-tight drip pocket at base of duct complete with drain, unless noted otherwise. Refer to Specification details. This shall not apply to kitchen exhaust systems. Refer to plans for drain requirements.

3.4 MOTORIZED DAMPERS

.1 Units in acoustically lined ducts are to be sized to suit clear dimensions of acoustic insulation and not of size to suit sheet metal duct. Where units are located in acoustic lined ducting, install heavy gauge metal channel and fasten to metal duct to receive damper frame. Space between channel and duct to be filled with flexible insulation.

.2 On plenums and ducts with external insulation, Section 15900 to provide channel mounting frame of same thickness as insulation. Pack channel frame with loose fibreglass insulation.

3.5 DUCT ACCESS DOORS

.1 Locate properly for inspection and servicing. Doors and frame to be rigid, close-fitting, with rubber gaskets, galvanized hinges with brass pins and at least two galvanized cam locks. Rivet frame and hardware to ducts.

.2 Where impossible to swing access doors, install removable door with four cam locks.

3.6 FILTERS

.1 During construction period, no air system to be started unless air filters function as specified. At time of building acceptance by The Citys, all filter banks to be in perfectly clean operating condition. There shall be no air bypass around or in filter banks.

.2 Install all filters as per mfg. published installation data.

3.7 FAN SYSTEMS - GENERAL

.1 Use flexible connections at inlets and outlets where ductwork and plenums connect to fans and air-handling equipment.

.2 Fan Vibration Isolation

.1 Install as per Isolation manufacturer's published data.

.3 All equipment shall be installed in strict accordance with manufacturer's published data.

.4 Protection of Fan Equipment Before Installation

.1 Grease shafts, sheaves, etc. to prevent corrosion. Fan bearings to be greased or oiled at time of building takeover.

3.8 DIFFUSERS, REGISTERS AND GRILLES

.1 Provide sponge gasket behind each outlet or inlet and adequate fastenings to prevent streaking between outlet and duct, wall or ceiling.

.2 Shop Drawings to be accompanied by itemized list indicating unit locations by room number and unit size. Itemized list noted above shall be certified by direct representative.

.3 Submit typical unit c/w all accessories, specified finishes, for all diffusers, grilles and registers, if requested by Contract Administrator. Materials installed on job to be fully equal to samples submitted for approval.

.4 Should there be any confliction in location of grilles, registers and diffusers with lights, etc. matter to be referred to Contract Administrator for directive. If requested by Contract Administrator, re-locate grilles, diffusers and registers and ductwork attached, within 1.2m (48") of locations noted on Drawings, without extra cost to The Citys. Refer to Drawings for additional requirements.

3.9 TESTING OF DUCTWORK

.1 Visually and audibly check for air leaks that can be heard or felt under normal operating conditions. Repair all leaks in ductwork.

3.10 BELT DRIVEN CENTRIFUGAL INLINE FAN

.1 Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions

.2 Examine areas to receive fans. Notify the Contract Administrator of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected

.3 Ensure roof openings are square, accurately aligned, correctly located, and in tolerance

.4 Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in Air Distribution (Division 23)

.5 Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and Contract Drawings

.6 Install fans in accordance with manufacturer's instructions

.7 Refer to Installation, Operation, and Maintenance Manual (IOM)

.8 Adjusting
- .1 Adjust exhaust fans to function properly
- .2 Adjust Belt Tension
- .3 Lubricate bearings
- .4 Adjust drive for final system balancing
- .5 Check wheel overlap

.9 Clean as recommended by manufacturer. Do not use Material or methods which may damage finish surface or surrounding construction

.10 Protect installed product and finished surfaces from damage during construction

.11 Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

.2 Wherever words "shall be capable of" appear in Specifications, interpret as meaning that; where feature or performance referred to is being applied, that feature or performance shall be provided.

1.2 WORK INCLUDED

.1 Labour, Material, plant, tools, equipment and services necessary and reasonably incidental to completion of control/instrumentation systems as noted herein and/or on the Drawings.

.2 Control equipment to be product of Johnson Controls.

.3 Section 15900 shall supply, install & wire all control components required by the new equipment to achieve sequence of operation specified in this Section.

.4 Division 15900 shall coordinate with Division 15600 & Division 15800 prior to and during start up and commissioning.

.5 This building has an existing Johnson Metasys B.M.S. (Building Management System). Division 15900 shall provide new control wiring for new equipment & run back to B.M.S. as required. The B.M.S. shall be expanded as required to monitor & control all the new equipment.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 15010 Mechanical General Provisions

.2 Section 15600 Liquid Heat Transfer

.3 Section 15800 Air Distribution

.4 Section 15990 Testing, Adjusting and Balancing

.5 Section 16010 Electrical

1.4 WORK BY OTHER SECTIONS

.1 Section 15600 to distribute and mount all pipe connected equipment including valves, thermometers, flow switches etc. in their respective locations, as supervised by Section 15900.

.2 Section 15800 to distribute and mount all motorized dampers, etc. in their respective locations, as supervised by Section 15900.

.3 Section 15800 shall provide additional galv. iron baffles as required at all mixed air plenums to ensure good air mix so controllers can function properly. Section 15900 shall assist Section 15800 in establishing locations of such baffles.

.4 Division 16 - Electrical to supply and install all conduit, wire and connections from the distribution panels to line side of magnetic starters and thermal overload switches, and from load side of starters and switches to motors.

1.5 ELECTRICAL WIRING PERFORMED BY SECTION 15900

.1 Supply and installation of all conduit, wire, electric relays, connections and other devices required for control circuit wiring for systems as specified in Section 15900, whether line or low voltage, shall be responsibility of Section 15900, except as noted above.

.2 Section 15900 shall either use own electricians, retain and pay for services of successful Division 16, or use an electrical Sub-contractor acceptable to Contract Administrator to supply and install all conduit and wiring for systems as specified in this Section.

.3 Factory trained servicemen in employ of manufacturer, shall make final wiring connections on all components, mount and electrically connect all controls.

.4 Electrical wiring shall be installed in conformance with CSA, ULC, Manitoba Building Code, National Building Code of Canada 1990 and standards set in Division 16 of this Specification.

.5 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.

.6 Wire all safety controls in series with both 'Hand' and 'Auto' starter positions to ensure that systems are properly protected.

.7 Section 15900 shall provide all other conduit and wiring required for Section 15900 systems operation, including tie-ins from Section 15900 supplied relays to motor starting circuits.

.8 As a minimum, provide separate, dedicated conduit system for each of following. Conduit to be minimum 19mm EMT.

.1 B.M.S. transmission wiring.

.2 All other wiring connected to an electronic control system including sensor and control wiring associated with DDC panels, DGP's, etc., which are connected to the B.M.S. system or are capable of being connected at some future date.

.3 Sensor and control wiring for stand-alone pneumatic/ electric control systems. Conduit identification labels shall state "BMS" for 1., and 2., 3. above, and "CONTROL WIRING" for above.

.9 If approved by system manufacturer, cable up to 30 Volts may be installed in extra-low voltage communication cable tray.

Part 2 Products

2.1 IDENTIFICATION OF EQUIPMENT - GENERAL

.1 Use engraved black and white laminated plastic, 25mm x 62mm (1") x (2-1/2"), at all thermostats, thermometers, panels, etc., supplied so as to clearly indicate service of particular device. Does not apply to room thermostats. Manual switches, unless they come with standard nameplates, and thermostats, thermometers, switches, etc., installed on local panels to be similarly labelled. All controllers, relays, etc. mounted inside local panels may have tape labels.

.2 Provide lamacoid identification plates fastened with rivets or self-tapping screws at all equipment supplied by Section 15900 so as to clearly indicate service of particular device. All manual switches, unless they come with standard nameplates, shall be similarly labelled.

.3 Equipment installed on surfaces of local panels shall be similarly labelled. Equipment mounted inside local panels, must have permanent plate labels with self-tapping screws. Tape labels are not acceptable.

.4 Identification plates, by Section 15900, to be white background with minimum 5mm high black letters, unless specified otherwise.

.5 Information on lamacoid identification plates to be consistent with 'as-built' control Drawings.

.6 Prior to lamacoid fabrication, submit copies of control Drawings and complete list of proposed wording for each lamacoid, for approval by Contract Administrator and The City. Include copy of approved lamacoid list in each Maintenance/Operating Manual.

2.2 INSTRUMENT CABINETS

.1 Provide at each system or groups of systems, cabinet type metal control panel with all instruments mounted inside locking cover. All panels shall have same key. Temperature indication and control point adjustments and gauges labelled as to function with lamacoid nametags fixed to panel face with self-tapping screws. All electrical equipment mounted in cabinet to be pre-wired to labelled terminal strips.

2.3 AUTOMATIC CONTROL VALVES

.1 Bodies shall be cast brass up to and including 50mm (2") I.P.S. and cast iron 64mm (2-1/2") I.P.S. and over.

.2 All automatic control valves to be fully proportioning with modulating plug or V-port inner guides, unless otherwise specified. Valves to be quiet in operation and failsafe in either N.O. or N.C. position in event of air failure. Valves to be capable of operating in sequence when required by sequence of operation. All control valves shall be sized by control manufacturer and shall be guaranteed to meet heating and cooling loads as specified. All control valves to be suitable for system pressure involved. Valve operators shall be of molded rubber diaphragm type. Body pressure rating and connection type (screwed, flared, or flanged) shall conform to pipe schedule elsewhere in this Specification.

.3 Steam control valves, single seated type with equal percentage flow characteristics. Preheater valves and direct radiation valves shall be N.O. type. Reheat and water heater valves shall be N.C. type. Valve discs shall be composition type for steam pressure up to 241.5 kPa (35 psig) and shall be of stainless steel for steam pressures above 241.50 kPa (35 psig).

.4 Butterfly valves used as control valves, shall be high performance type with heavy-duty shaft bearings and adjustable heavy-duty packing.

.5 Maximum valve pressure drop:

.1 Steam: 34.5 kPa (5 psig), unless noted otherwise

2.4 CONTROL DAMPERS

.1 Provide all control dampers of type and sizes indicated. All outside, exhaust and relief control dampers to be opposed blade low leakage moduflo dampers. Frames to be heavy ga. galv. steel formed for extra strength with mounting holes for flange and enclosed duct mounting. Dampers available in 50mm (2") size increments from 203mm (8") horizontal and vertical to 1219mm (48"). Requirements over 1219mm (48") to be standard modules with interconnecting hardware. 1.6mm (16 ga.) damper blades, galv. steel, roll formed for high velocity performance. Blades of 203mm (8") width maximum; blade seals and spring loaded stainless side seals. Dampers and seals suitable for temperature ranges of -40 deg.C to 100 deg.C. Leakage shall not exceed 1% with approach velocity of 7.62M/s (1500fpm) when damper is closed against 100mm (4") W.G.

2.5 VALVE & DAMPER OPERATORS

.1 Electric:

.1 Electric proportional or two position type as required, with adjustable forward and return stops, aluminum housing and spring return.

.2 Operators mounted outside shall be c/w internal heater.

.3 Valve operators shall be of type to withstand temps. likely to be encountered in application.

.2 Size operators to guarantee component operation under maximum load. No damper operator shall be required to drive more than 2.5 sq.m. (27 sq.ft) of damper.

2.6 LOW TEMPERATURE CUTOUTS

.1 Provide on coils or where noted, low temperature cutouts with 6096mm (20 ft.) temperature sensitive elements wound across downstream face of coil.

.2 All air systems introducing O.A. shall have air side low temperature cut-out switch. If system does not have steam or water coil ahead of supply fan, safety control can be located on leaving side of fan.

.3 Cut-outs must have manual reset unless noted otherwise.

.4 Provide extra alarm contact to be used for B.M.S.

2.7 ROOM THERMOSTAT

.1 Proportional or snap action contact type to suit application. Provide with setpoint indicator thermometer and adjustable stops. Direct or reverse acting to suit system. Setpoint range adjustable from 16 deg C to 32 deg C.

.2 Provide blank covers with concealed adjustment and thermometers inside cover.

2.8 MISCELLANEOUS DEVICES

.1 Provide necessary relays, cumulators, three-way air valves, positioners, pneumatic electric switches, three-way solenoid valves, two-way and three-way air switches, clocks, transformers, etc. to make complete and operable system.

.2 Install on local panels, unless noted otherwise.

2.9 ALARM MODULE SEQUENCE

.1 Where reference is made to alarm annunciation in any operation sequences, provide equipment to accomplish following sequence for each point annunciated.

.1 Alarm condition - audible ON, corresponding visual point flashing.

.2 Acknowledge - audible OFF, visual ON steady.

.3 Normal - audible OFF, visual OFF.

.4 Test - audible ON, visual ON steady - all lights.

.2 Each subsequent alarm condition shall cause repeated sequence as detailed above whether or not previous alarm condition has been acknowledged.

2.10 SENSING WELLS

.1 Where required for sensing fluid temperatures, install thermowells. Do not use existing thermometer wells or strap-on surface thermo-couples.

.2 Thermowells shall be suitably sized for sensing element to be used and shall be of bronze construction c/w pipe fittings suitable for installation in piping Material as specified.

2.11 IDENTIFICATION OF DATA GATHERING & D.D.C. PANELS

.1 Provide lamacoid nameplates to identify following:

.1 Data Gathering Panel Title.

.2 Supply feeder panelboard number, circuit number, and panelboard location.

.2 Fasten nameplates with rivets or self-tapping screws to exterior of Data Gathering Panel door.

.3 Refer to subsection "Identification of Equipment - General", and comply with all requirements related to lamacoid nameplates.

.4 For each panel or terminal cabinet, indicate designation, system, load and area served. Provide directories to identify all termination points. For each termination point, identify equipment connected, equipment location and termination wire colour code or identification code number. Insert copy of directory in clear plastic pouch attached inside panel or terminal cabinet door, and insert copy into each Maintenance/Operating Manual. All wires or cable shall be colour coded and/or identified with identification code using wire markers. Information on data cards or directories shall be either typewritten or neatly printed with permanent ink.

2.12 FIELD DATA PANEL

.1 Factory wire and test. Encoding and decoding equipment shall be of printed circuit board construction.

.2 Design panel such that in case of localized trouble, panel can be isolated from system for testing and repairs without effecting normal operation of total system.

.3 Locations of field data panels shall be approved by Contract Administrator prior to installation.

.4 Panels shall be capable of handling multiple systems with ability to have at least two different and not necessarily sequential systems assigned to one panel.

.5 Each panel to operate set points in accordance with points list.

.6 On power failure at panel, each panel shall run through power failure routine so that no data will be lost either remotely or centrally. After power failure, each affected start/stop fan or motor to remain OFF until either operator at Central Console manually turns motor ON; or until automatic power fail restart programme starts. Power failure at one building shall not interrupt operation of remainder of system.

.7 Panels shall be individually fused for input power and separately fused for all control voltages.

.8 Panels shall be capable of electrically supervising all wiring required for security system points. Wiring shall be supervised for short circuits, open circuits and ground fault conditions, and shall transmit to CPU type of condition and location of circuit affected.

.9 Panels for building services (i.e. steam, chilled water, etc.) metering points shall be capable of storing consumption quantities peak demand levels, etc. for 72 hour period when central computer is off line for servicing or repairs.

2.13 SENSORS

.1 General:

.1 All temperature, R.H., pressure, etc. sensors shall be corrosively resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.

.2 All sensors shall be installed in strict accordance with mfg. recommendations.

.3 All motor (fans, pumps, etc.) operating status shall be obtained by using binary differential pressure sensors or current sensing relays as described herein. Auxiliary contacts in magnetic starters shall not be used to obtain motor status.

.4 All temperature, R.H., pressure, etc. sensors shall be electronic type. Pneumatic sensors shall not be acceptable.

.2 Temperature Sensors:

.1 Temp. sensors shall be precision elements with sensing to readout accurately of +\- 0.5 deg.C over entire range of element.

.2 Temp. element range shall be -40 deg.C to 60 deg.C or 40 deg. C to 120 deg.C as required by particular temperature being sensed.

.3 Duct mounted sensors shall be point type for use in return air systems and shall be averaging type for all other duct locations. Averaged sensors shall be of sufficient length to accurately determine correct average temperature.

.4 Room sensors shall be wall mounted with vented cover, back box and tamper proof screws.

.5 O.A. sensors shall be c/w weatherproof enclosure and sun shield.

.3 Analog Differential Pressure:

.1 Internal Materials to be suitable for continuous contact with the process Material measured including compressed air, water, glycol, or steam as applicable.

.2 Output variation of less than 0.2% full scale for supply voltage variations of +/- 10%.

.3 Combined non-linearity repeatability and hysteresis effects not to exceed +/- 0.5% of full scale output over entire range.

.4 Over-pressure input protection to a minimum of twice rated input.

.5 Differential pressure ranges shall be +/- 0.25, +/- 0.50, or +/- 1.0 as required to suit flow conditions.

.6 Provide isolation valves between sensor and fluid line.

.7 Steam flow shall be sensed using orifice plates. Provide differential pressure transducer and all necessary devices to ensure proper operation with B.M.S.

.4 Flow Sensors:

.1 Flow metering shall be to accuracy required for billing purposes. Sensors shall be accurate to +/- 1% over full range of sensor.

.2 Sensor range to suit flow.

.3 Sense chilled water flow using turbine flow meters. Provide 40:1 range for accurate flow measurement at low load conditions. Standard of Acceptance: Eng. Measurements Co. TMP-600.

.4 Sense steam and chilled water using orifice plates. Provide all necessary devices to ensure proper operation.

.5 Binary Differential Pressure:

.1 Pressure or differential pressure switches shall have ranges and rating applicable to pump and fan application as required.

.2 Pressure sensing elements shall be Bourdon tube, bellows, or diaphragm type.

.3 Adjustable set point and differential.

.4 Pressure switches shall be snap action type rated at 120 Volts, 15 Amps AC or 24 Volts DC.

.5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.

.6 Provide isolation valve between sensor and pressure source.

.7 Generally, current sensing relays shall be used for sensing fan and pump operating status, unless specifically indicated otherwise. Obtain operating status of fan or pump directly from binary differential pressure switch. Do not use auxilliary contacts in magnetic starters.

.6 Relays:

.1 DPDT relay with coils rated for 120V AC or 24V DC as required.

.2 Contacts rated at 5 Amps at 120V AC.

.3 Relays to be plug in type with termination base.

.7 Current Sensing Relays:

.1 Relays shall be capable of sensing over 0.1 to 5 Amp range, with adjustable trip point and 10 Amp rated SPDT contact output.

.2 Relay shall have adjustable hysteresis from 10% to 75% of sensing range.

.3 Latching capability shall be available.

.4 Relay shall be of plug-in configuration complete with termination base.

.5 Single and multiple phase current metering transformers shall be provided in ranges to suit application.

.6 Current sensing relays shall be used for sensing fan and pump operating status, unless specifically indicated otherwise.

.7 Install relays in NEMA tamperproof enclosure. Install current transformer downstream from motor disconnect or starter.

.8 Standard of Acceptance: Electromatic SM-115.

2.14 INTERCONNECTION WITH BUILDING MANAGEMENT SYSTEM (B.M.S.)

.1 The City has installed B.M.S.

.2 Control systems specified herein shall be adaptable to interconnections with this system i.e. following should be included in this Contract.

.1 On all alarm points provide extra set of contacts for connection to B.M.S.

.2 On all mixed air dampers provide necessary electro/pneumatic devices required to allow closed/auto operation of dampers from B.M.S.

.3 All input and output points which are connected to D.D.C. panels shall be interconnected to B.M.S. Provide all D.D.C. panel and B.M.S. software revisions and/or modifications to complete the B.M.S. connection.

.4 System programming shall include following provisions:

.1 Run times and number of starts for all equipment where on-off status is monitored, including all pumps and fans.

.2 Analog alarm limits on all analog sensing points (high and low where applicable).

.3 Sliding limits where setpoint moves in controlled manner.

.4 Current set point provided as keyname.

.5 Keyname listing as indicated on detail sheets.

.5 Update all B.M.S. Drawings and documentation.

2.15 IDENTIFICATION OF EQUIPMENT CONTROLLED BY B.M.S.

.1 Provide adhesive back tags for all pieces of equipment controlled by the B.M.S.

.2 Tags shall be white background with red letters, 100mm wide x 70mm high, with rounded corners, and shall read as follows:

"WARNING

- THIS EQUIPMENT IS UNDER CENTRAL CONTROL AND MAY START OR STOP WITHOUT WARNING
- Leave starters in 'AUTO' position.
- Phone BMS Office to inform monitoring room if equipment is being shutdown.
- Ensure disconnect is locked off prior to Working on equipment."

.3 Tags shall be of 3M Material, similar to that used for renewal tags on automobile licence plates, as available from Aristo-Print Limited, Winnipeg.

.4 Submit one sample tag for approval prior to installation.

2.16 FAN SYSTEM CONTROLS - GENERAL

.1 Following control sequences shall apply to all supply fan systems whether specifically noted in sequence of operation or not.

.2 Where fan systems have outdoor and return air dampers modulated to maintain mixed air, discharge air, or room temperature, provide adjustable (0 - 1 min.) restriction feature to retard opening of O.A. damper on system start up and enable heating source controls to come into control and prevent nuisance tripping of low limit protection controls.

.3 Provide interlocks to ensure system controls energize and associated return and/or exhaust fans run when supply fan runs.

.4 Provide interlocks to ensure auxiliary equipment such as outdoor air dampers, relief air dampers, etc. are shut off and/or closed when supply fan is off.

.5 Where steam, heating coils are utilized, the mixed air controller shall modulate media flow through coil when supply fan is off in order to prevent overheating condition within system ductwork.

.6 Provide all fan systems that introduce O.A. with low limit control in discharge air to shut down supply fan and activate local alarm when discharge air temperature drops below 3 deg.C(37 deg.F). Locate low limit in manner that shall protect heating and cooling coils, and at same time not be subject to nuisance tripping.

.7 Provide all fan systems that introduce O.A. with adjustable O.A. damper minimum position controls. Where O.A. dampers are larger than 1 sq. m (10 Sq. ft.), dampers shall be split into two sections horizontally. Each section shall be driven by separate operator and lower section shall close when O.A. temp. falls below 0 deg.C (32 deg.F). Minimum O.A. controls shall override this requirement and modulate lower section open to maintain minimum O.A. quantity specified.

.8 Where relief air dampers are not directly ducted to supply/return fans, provide backdraft temp. controller to prevent backdraft condition from occurring.

.9 On 100% O.A. systems, provide end switch on O.A. damper to ensure O.A. damper is fully open prior to starting fan.

2.17 REDUNDANT SERVICES AND EQUIPMENT

.1 Remove existing controls, control air tubing, equipment etc. which are not necessary for revised systems. The City shall have opportunity to retain used Materials.

2.18 MACHINE ROOM VENTILATION

.1 The air handling system will be a packaged unit with remote damper sections. Dampers and actuators to be supplied by Section 15900.

.2 The air handling unit shall have DDC controls, and be controlled by the BAS system.

.3 The supply AHU-1 and return/exhaust fan EF-1 shall operate together on low speed. DDC controls shall control the unit to maintain discharge air setpoint.

.4 Provide a refrigerant detection sensor which through the BAS will actuate the motorized outdoor air intake and relief air dampers fully open, and the mixing dampers closed upon detecting a refrigerant leak in the space. The AHU and exhaust fan shall also switch to high speed. In the event the gas levels rise above the high limit setting, an alarm will annunciate at the BAS controller.

.5 AHU controls shall take advantage of free cooling with economizer control. On a call for cooling, with outdoor air temperature above the mechanical cooling lockout temperature, and below the economizer lockout temperature, mixed air dampers shall be modulated to the 100% O.A. position. Requirements for cooling shall be determined by space sensor located in space.

.6 System controls sequence is as follows:

.1 In the unoccupied mode with chiller system note operating, the air handling unit fan shall cycle on low speed to maintain space temperature. Dampers shall be in full return mode. On a call for heating, the DDC controller shall modulate the 2-way steam heating valve to maintain discharge air temperature setpoint. On a call for cooling, mixing dampers shall modulate to maintain a 13 deg. C discharge air

temperature, exhaust fan EF-1 shall operate and exhaust and return dampers shall modulate with AHU-1 dampers.

.2 When the occupied/unoccupied switch is set to occupied, and chiller system is note operating AHU-1 and EF-1 shall operate in low speed with 5% outdoor air minimum. On call for heat, steam valve shall be modulated to maintain space temperature. On a call for cooling, mixing dampers shall modulate to maintain a 13 deg. C discharge air temperature, exhaust fan EF-1 shall operate and exhaust and return dampers shall modulate with AHU-1 dampers.

.3 In occupied or unoccupied mode, and chiller system is operating or during a refrigerant leak detection, AHU-1 and EF-1 shall operate at high speed, outdoor air and relief air dampers shall open fully, and return dampers shall close fully. Steam valve shall modulate to maintain discharge air temperature of 15 deg.C.

.7 Provide an audible/visual alarm outside the chiller room which will annunciate on a detection of refrigerant gas. Provide an occupied/unoccupied switch on alarm panel with a pilot light at the same location which will indicate the AHU-1, EF-1, and alarm status. Alarm shall include alarm light, pilot light push to test, buzzer and alarm silence.

.8 Provide a remote audible/visual alarm sub-panel in existing electrical room. Remote alarm shall include alarm light, pilot light push to test, buzzer and alarm silence.

.9 The filter shall have a differential pressure sensor to monitor pressure across summer/winter banks for filter status.

.10 The following lists the minimum I/O points to be sensed/controlled by the DDC system

.1 Analogue Inputs

.1 Space temperature
.2 Discharge air temperature
.3 Mixed air temperature
.4 Return air temperature
.5 Filter differential pressure

.2 Analogue Outputs

.1 Heating valve control
.2 AHU-1 mixed air damper control
.3 AHU-1 outdoor air damper control
.4 EF-1 return air damper control
.5 EF-1 relief/exhaust air damper control

.3 Binary Inputs

.1 Low temperature limit switch
.2 Supply fan status
.3 Exhaust fan status
.4 Refrigerant High Limit alarm

.4 Binary Outputs

.1 Supply fan low/high speed
.2 Return fan low/high speed

2.19 CHILLER MONITORING CONTROL SYSTEM

.1 The chillers will be supplied with packaged controls.

.2 Provide alarm and status for each chiller from packaged controllers.

2.20 CHILLED WATER PUMP MONITORING SYSTEM

.1 Chilled water pumps P-40 and P-41 shall operate continuously when called on by the packaged chiller control system. Provide chilled water pump status at BAS.

.2 Failure of a pump will result in an alarm being sent to the BAS operator Workstation.

.3 The following lists the minimum I/O points to be sensed/controlled by the DDC system

.1 Analogue Inputs

.1 CHW supply temp

.2 CHW return temp

.2 Binary Inputs

.1 Pump P-40 status

.2 Pump P-41 status

2.21 CHILLED WATER SYSTEM CONTROL

.1 The chilled water system control and monitoring system shall include operation of chiller, cooling tower, chilled water pump, and condenser pump. The controls are a combination of BAS controls and package controls. The following sequence describes the system operation.

.1 The DDC system will enable the control system packaged with the chiller on demand for chilled water. The packaged chiller controller shall control the chiller, chilled water pump, condenser water pump and cooling tower.

.1 The chiller controller will start the chilled water pumps.

.2 The chiller controller will start the condenser pump.

.3 The chiller CH-1 VFD shall operate in response to maintaining the supply water temperature.

.4 3-way control valve on cooling tower return line to modulate to ensure the fluid temperature is greater than the minimum temperature set point allowable for the chiller condenser.

.2 Field installed flow switches supplied with the chillers to monitor chilled water and condenser water flow shall disable the chiller in a low flow condition. An alarm shall be annunciated at the BAS.

Part 3 Execution

3.1 GENERAL

.1 Control components and interconnecting tubing systems to be installed by trained control mechanics, regularly employed by Section 15900.

3.2 EXISTING BUILDING SYSTEM

.1 During Bid Opportunity period visit jobsite to review section of existing systems relating to the new installation.

.2 Co-ordinate new installation with existing system. Make revisions to existing systems as noted on Drawings and/or in Specifications.

3.3 OPERATING INSTRUCTIONS AND AS-BUILT INFORMATION

.1 Provide operating instructions as specified elsewhere. Include schematic Drawings of all control systems including control sequence write-up.

.2 Provide three hard cover copies of complete information pertaining to temperature control\instrumentation system for The City's permanent record. This to include following:

.1 As-built schematic control diagrams with complete control sequence write-up.

.2 Operator's manual including maintenance instructions.

.3 Engineering data and data product sheets.

.4 Parts list of all components including repair instructions.

.5 Suggested spare parts list.

.3 Provide in DDC operator's manual, details of all functions, operator interaction with the system, complete with examples. Manual shall be written by professional technical writers. Provide operator's pocket guides for quick reference on day-to-day routine operations.

3.4 SERVICE AND WARRANTY

.1 Upon completion of installation, all thermostats, control valves & all other equipment shall be adjusted as required to place system in complete operating condition subject to Contract Administrator's approval. Make all adjustments in collaboration with field Contract Administrator responsible for balancing air and water system.

.2 If within one year from date of completion as interpreted by Contract Administrator, any of equipment herein described is proven to be defective in Workmanship or Materials, it shall be replaced or repaired free of charge to The City.

.3 After installation completion, provide any service incidental to proper performance of control system under guarantees outlined above for guarantee period. Normal maintenance of system or adjustment of components is not to be considered part of guarantee.

.4 Provide two additional service inspections, one prior to change of system; i.e. heating to cooling (Spring). Provide The City with three days prior notice before inspection is to take place so The City can arrange to have his representative present during full inspection. Following each inspection an itemized report shall be forwarded to The City. Inspections shall include calibration of controllers and sequencing and lubrication of all dampers, damper operators and valves, trip testing of high and low limit protection devices.

3.5 INSTRUMENT MOUNTING

.1 Mount transmitters and sensing elements on pipework at location where temperature is to be sensed. Care shall be taken to prevent breaking of insulation barrier and where practicable instruments shall be stood off on sheet metal brackets to allow installation of insulation behind instrument.

3.6 LOW TEMPERATURE CUTOUTS

.1 Wire into "HAND" and "AUTO" positions of fan starter switch circuits, or if there is none, wire into local fan circuit such that, when any 305mm (12") section of element senses temperature below +2 deg. C, supply fan to de-energize and O.A. dampers to close.

3.7 ROOM THERMOSTATS

.1 Room thermostats and sensors shall be located where shown on Drawings. Mount thermostats and sensors approximately 1400mm (56") above finished floor.

.2 Calibrate all thermostats and confirm to The City that this Work has been done.

3.8 CONTROL DAMPERS

.1 Linkage hardware to be readily accessible for maintenance after installation.

.2 Where dampers are required to be assembled from multiple sections, each section shall be driven by an independent operator, with no single operator driving a damper section having a surface area greater than 2.5 sq.m.

.3 Vortex dampers for fans are supplied by fan manufacturer.

3.9 SENSING WELLS

.1 Wells shall be installed in piping at elbows where piping is smaller than length of well to effect proper flow across entire area of the well. Well shall not restrict flow area to less than 70% of line-sized-pipe normal flow area.

.2 Pipe wells as required shall be furnished to Section 15400 and Section 15600 for installation at appropriate sensing points in pipework.

.3 Void between inside of well and outside of sensing bulb shall be filled with heat transmission grease.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

.2 Testing, Adjusting and Balancing (TAB) Agency shall be an experienced, independent Contractor specializing in the testing, adjusting and balancing of HVAC systems.

.3 TAB Agency shall be a member of the Associated Air Balance Council (AABC) and Work shall carry standard AABC Certificate of Guarantee.

.4 Include extended service for 90 days after completion of final balancing Work, during which time Contract Administrator at his discretion may request re-check or re-setting of any systems and/or equipment listed in test report

1.2 SCOPE OF WORK

.1 Provide complete testing, adjustment and final balancing of all building air systems.

.2 Provide complete testing, adjustment and final balancing of liquid based building HVAC systems including chilled water and condenser water systems.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 15010 Mechanical General Provisions

.2 Section 15600 Liquid Heat Transfer

.3 Section 15800 Air Distribution

.4 Section 15900 Controls/Instrumentation

Part 2 Products

2.1 BALANCING REPORTS

.1 Provide two copies of detailed draft balancing report to Contract Administrator for review after completion of all adjustments.

.2 Final balancing report shall incorporate all changes resulting from Contract Administrator's comments and any adjustments undertaken since the draft report was issued.

.3 Provide four copies of final balancing report.

.4 Provide sufficient number of copies of final balancing report to Mechanical Subcontractor for inclusion in Operating & Maintenance Manuals.

Part 3 Execution

3.1 GENERAL

.1 All instruments used shall be accurately calibrated and maintained in good Working order. If requested, tests shall be conducted in the presence of Contract Administrator and/or his representative.

.2 Schedule all Work to comply with completion date.

.3 Work shall not begin until system has been completed and in full Working order. Division 15 shall put all heating, ventilating, and air-conditioning systems and equipment into full operation, as season would demand, and shall continue operation of same during each Working day of testing, adjusting and balancing.

3.2 AIR BALANCING

.1 Coordinate with Sections 15600 and 15800 to ensure installation of all manual adjusting dampers and pitot tube enclosures are as indicated, as specified and as required to allow proper adjustment of air systems.

.2 Sections 15600 and 15800 to provide initial alignment and tension of all fan pulleys and belts supplied by them.

.3 Testing Procedure:

- .1 Test, adjust and record all fan speeds, motor amperes.
- .2 Make pitot tube traverse to main supply and obtain cfm at fan.
- .3 Test and record static pressure for each system at fan suction and discharge.
- .4 Adjust all supply and return air ducts to proper design cfm.
- .5 Test and adjust each diffuser, grille, and register to within 5% of design requirements. Balance as per manufacturer's recommendations.
- .6 All outlets shall be adjusted to provide proper throw and distribution, in accordance with Contract Administrator requirements.
- .7 Fan operating conditions tested shall confirm air delivery within 5% of manufacturer's fan curves.
- .8 Systems shall be balanced so that fans operate at lowest possible static pressure.
- .9 Inlet vanes or variable speed drives shall not be used to reduce fan capacity to achieve balance condition. Balance on fan drive only with VAV or VSD at 100% capacity.
- .10 Prepare single line diagrams of duct systems indicating terminal outlets identified by number. List on data sheets all such outlets denoted by the same numbers, including the outlet sizes, 'K' factor, location, cubic feet per minute and jet velocity. Provide this data for all supply, return and exhaust air systems.

.4 As part of Work of this Contract, Sections 15600 and 15800 shall make any changes in the pulleys and belts, and any additional manual dampers for correct balance as recommended by Section 15990, at no additional cost to The City. Section 15990 shall provide final alignment and tension adjustment of fan pulleys and belts.

3.3 WATER BALANCING

.1 Completely balance pumps and piping systems by adjustments of plug cocks, globe valves or other control devices, to obtain the flow quantities. During balancing set controls for full-flow through coils. Set automatic throttling valves in the full-open position. Close bypass port on automatic 3-way valves.

.2 Balance fluid flow through coils, converters, cabinet heaters, heat exchangers, unit heaters, etc., in accordance with design.

.3 For flow measuring devices, record pipe size, manufacturer and size of device, and direct reading of the differential pressure, and calculated final flow.

.4 Balance flow through equipment and coils by means of flow measuring devices and pressure drop. Obtain curves from equipment manufacturers indicating relationship between flow and pressure drop through coils and equipment. Take readings on calibrated test gauges.

.5 Upon completion of fluid balance, reconcile total heat transfer through all heating and cooling coils by recording entering and leaving water temperatures and entering and leaving air dry bulb and wet bulb temperatures.

.6 Upon completion of balancing, adjust differential bypasses and 3-way valve bypasses for same pressure drop on full bypass as on full flow.

.7 Section 15600 shall supply and install water metering systems and devices. Refer to Section 15600.

.8 Equipment Data

.1 Equipment lists shall include all information noted in schedules.

.9 After entire installation has been completed, make required adjustments to balance valves, air vents, automatic controls, pumps until performance requirements are met. Make these adjustments with equipment operating. During such periods of adjustment prior to date of acceptance of mechanical systems, operate equipment. After date of acceptance of mechanical systems, The City's maintenance personnel will operate equipment.

.10 During the first year of operation Section 15990 shall repeat these adjustments for each of immediately following three seasons of the year.

.11 Division 15 sub-contractor to install red valve tags onto all balancing valves, as specified under Section 15050, subsection "Identification of Valves". Section 15990 to add following information onto each balancing valve tag; valve final setting position, date of final adjustment, TAB Agency name and name of individual who made final adjustment.

3.4 SYSTEM CHECK

.1 Provide spot checks of systems if called upon by Contract Administrator. If capacities, fan speeds, ratings, etc. do not agree with submitted balance report, rebalance system or systems in question, until satisfactory results are received.

END OF SECTION

Air Handling Units

AIR HANDLING UNIT No.	**AHU-1**			
SERVICE	Machine Room			
MODEL	Eng Air LM6/C			
SUPPLY FAN - SIZE/TYPE	18/18 FC DIDW			
AIRFLOW RATE - HIGH SPEED (l/s) (cfm)	**2360**		5000	
AIRFLOW RATE - LOW SPEED (l/s) (cfm)	**1180**		2500	
EXTERNAL STATIC REQUIRED (Pa) (in.)	**50**		0.20	
MOTOR (bkW/kW) (Bhp/Hp)	**1.04**	**1.49**	1.39	2.00
SPEED (rpm)	555			
FILTER SECTION	Merv 6 Pleated			
FILTER NUMBER & SIZE (mm)	3:16"x20"x2", 3:20"x20"x2"			
HEATING COIL SIZE (h x l)(mm) (in.)	**1448**	**648**	57	26
MEDIUM	5 psig Steam			
OUTPUT CAPACITY (kW) (MBH)	**133**		454	
ENTERING AIR TEMP. (°C) (°F)	**-30.00**		-22.0	
LEAVING AIR TEMP. (°C) (°F)	**16.72**		62.1	
MAX. AIR PRESSURE DROP (Pa) (in.)	**28**		0.11	
MAX. FACE VELOCITY (m/s) (fpm)	**2.55**		501	
UNIT WEIGHT (kg) (lbs)	**384**		845.00	
UNIT ACCESSORIES	- 2 Speed Motor			
	- External Spring Isolators			

SMS ENGINEERING

Air Handling Unit Schedule

Project:	**Public Safety Building 151 Princess Cooling Plant Replacement**		
File:	09-307-01	Designer:	DH
Date:	Nov-12	Sheet:	**MS-1**

Fan Schedule

FAN NO.	FAN TYPE	LOCATION	FAN MODEL	CAPACITY High Speed (cfm) (l/s)	CAPACITY Low Speed (cfm) (l/s)	E.S.P. (in. W.G.) (Pa)	SPD. (rpm)	OUT. VEL. (fpm) (m/s)	BRK. (HP) (BkW)	MTR. (HP) (kW)	REMARKS
EF-1	Belt Drive Centrifugal Inline Fan	Machine Room	EH Price BSQ-180-15	**5000** 2360	**2500** 1180	**0.20** 50	1266	0.00	**1.26** 0.94	**1.50** 1.12	- 1 Winding - 2 Speed Motor - Spring Isolators

Fan Schedule

SMS ENGINEERING

Project: **Public Safety Building 151 Princess Cooling Plant Replacement**

File: 09-307-00 Designer: DH

Date: Nov-12 Sheet: **MS-2**