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MECHANICAL SPECIFICATION

FOR

LEGAL AID

OFFICE RENOVATION

20 DUNDAS STREET WEST

2ND FLOOR

THIS SPECIFICATION SHALL BE READ IN CONJUNCTION WITH DRAWINGS:

AS NOTED ON DRAWING TM-0.0

OUR PROJECT NUMBER:

94013.051.M.001

DATE:

2017-10-13

ISSUED FOR:

TENDER

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END OF SECTION 15000

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.
 - 1.1.2. The Specification is divided into Sections which are not intended to identify contractual limits between Sub-Contractors nor between the Contractor and his Sub-Contractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.
 - 1.1.3. Provide mechanical components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.
 - 1.1.4. The Drawings and Specifications shall be read in conjunction with base building drawings and specifications. The base building design documents are available for review at the Building Managers Office. The most stringent requirements will apply.
 - 1.1.5. Where the Specification Sections make mention of the "Owner" the contractor shall assume this to also mean "Landlord, or Lessor".
 - 1.2. INTENT
 - 1.2.1. Mention in the Specifications or indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
 - 1.2.2. The Specifications are an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.
 - 1.2.3. Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.
 - 1.3. SECTIONS AFFECTED
 - 1.3.1. These instructions apply to and form a part of all Mechanical Sections.
 - 1.4. REGULATIONS
 - 1.4.1. Work shall be performed in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
 - 1.4.2. The plumbing and drainage systems shall comply with regulations respecting plumbing made under the Ontario Water Resources Act except as modified by rules, regulations and by-laws of authorities having jurisdiction.

- 1.4.3. These specifications are supplementary to the requirements above.
- 1.4.4. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the Consultant.

- 1.5. PERMITS, FEES INSPECTION
 - 1.5.1. Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the work of this Division.

- 1.6. EXAMINATION OF SITE
 - 1.6.1. Before submitting Bids, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.
 - 1.6.2. Locate all existing services that are to be extended and the routing of new services shall be coordinated with all Trades prior to installation.

- 1.7. DRAWINGS, CHANGES AND INSTALLATION
 - 1.7.1. The Drawings shall be considered to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operational installation.
 - 1.7.2. The location, arrangement and connection of equipment and material as shown on the Drawings represents a close approximation to the intent and requirements of the work. The right is reserved by the Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
 - 1.7.3. In order to show more clearly the arrangement of the work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standard Details and to the Specifications to determine the requirements.
 - 1.7.4. Certain Details indicated on the Drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence.
 - 1.7.5. All piping and ductwork in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed and accepted by the Consultant. No piping shall be concealed in outside walls.
 - 1.7.6. The location and size of existing services shown on the Drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.
 - 1.7.7. Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, shall be made at no extra cost to the Owner.
 - 1.7.8. Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.

- 1.7.9. Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.7.10. Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the work of other Trades. Any problems that cannot be solved in agreement with the other Trades affected, shall be submitted for decision. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Owner.
- 1.7.11. Location of diffusers, grilles registers, thermostats, sprinklers and all other equipment shown on plans is diagrammatic. Layout of each device in finished areas is critical in terms of symmetry and location. Refer to Architectural or Interior Design Drawings and to site instructions in all regards. Any work not installed in the correct location (at the sole discretion of the Consultant) shall be remedied by this Contractor at his expense. This Contractor is responsible for mark-out of his work, fully co-ordinated with all other trades, in sufficient time for review by Consultant prior to rough-in. All mechanical and sprinkler services shall be located precisely.
- 1.8. MATERIALS
- 1.8.1. Materials and equipment supplied by this Division shall be new and free from defects and shall be as specified by the manufacturer's name and catalogue reference.
- 1.8.2. Where a certain manufacturer's equipment has been specified by name or model number, the Contractor shall be responsible for ensuring that the performance and quality of any proposed alternative meets the specified equipment and that the same access or maintenance space is available for the alternative manufacturer's equipment and that piping, duct and electrical connections can be made at no extra cost to the Contract.
- 1.9. CO-OPERATION WITH OTHER DIVISIONS
- 1.9.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.9.2. Pipes transporting hot fluids shall be installed at least 150 mm (6 in.) away from pipes carrying cold fluids, unless approval from the Consultant is obtained to install services closer than 150 mm (6 in.).
- 1.9.3. Electrical conduits shall not touch or be supported from piping or ductwork.
- 1.9.4. Each Section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other Sections or Divisions. Where the space allocated to another Section or Division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various Sections and Divisions. Relocation of materials and work involved shall be paid for by the Section responsible for the encroachment at no extra cost to the Owner.
- 1.9.5. Supply all items to be built in ample time for rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.
- 1.9.6. The Contractor shall confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical Division prior to ordering the equipment. Any discrepancy between the requirements identified within the Contract

Documents and those of the Electrical Division shall be reported to the Consultant and the equipment shall be adjusted to suit the appropriate power requirements. Failure to perform this coordination prior to ordering of the motors or equipment shall result in correction at no additional cost to the Owner.

1.10. TEMPORARY USE OF EQUIPMENT

1.10.1. Where the mechanical systems are operated during construction, the Mechanical Contractor shall maintain the system and equipment in proper operating condition.

1.10.2. Prior to application for substantial performance of the work as certified by the Consultant, the systems and equipment shall be returned to the initial new condition by replacing used air filters with new air filters, cleaning the air side of all coils in the air handling systems, replacing used belts in belt drives with new belts, lubricating all bearings according to manufacturer's factory standards and adjusting the thermostatic control system according to specifications and/or to suit the Owner.

1.11. EXISTING SERVICES AND EQUIPMENT

1.11.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the Consultant so as to avoid any interruption of such services during normal working hours. If necessary, changes and connections to existing services shall be made outside of normal working hours, at no extra cost to the Contract.

1.11.2. Whenever existing services or equipment are to be removed, all piping and ductwork for such services or equipment shall be removed back to the main, nearest pipe or duct and any open ends securely capped or plugged in an approved manner unless otherwise shown. If necessary to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this Division.

1.11.3. Whenever it becomes necessary to relocate existing piping, ductwork or equipment to make possible installation of the work under this Contract, such relocation shall be done by this Division without additional cost to the Contract.

1.11.4. Where connections are made to existing services, existing insulation shall be made good under this Division.

1.12. INTERRUPTION OF SERVICES

1.12.1. Any interruption of the mechanical services to any part of the building shall come at a time agreeable to the Consultant and Landlord. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.

1.13. STATEMENT OF PRICES

1.13.1. For the purpose of progress applications the Contractor shall submit a statement of his estimated prices for the various portions of the work, including labour, materials and equipment shown separately. The total price of all portions of the work shall equal the total price of the work covered under the Mechanical Division.

1.13.2. The Contractor shall submit the breakdown of work for this Contract to the Consultant for review and approval. The breakdown shall be in sufficient detail to enable the Consultant to

evaluate the progress of work and shall identify all major equipment, components and sub trades.

- 1.13.3. All shutdown, draining, filling and chemical treatment of any portion of the existing base building piping systems shall be performed to the satisfaction of the Landlord's building operations staff and shall be co-ordinated with the Landlord for time and duration of interruptions. Comply with all of the Landlord's instructions and include for all costs of this work, including work performed by the Landlord's chemical treatment supplier, in the tender price.

1.14. METRIC CONVERSIONS

- 1.14.1. Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.

- 1.14.2. Conform to the Canadian Metric Practice Guide CSA-CAN3-2234-1-89

1.15. DEMOLITION

- 1.15.1. The Demolition Drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected. Open shafts, walls and ceilings as required to examine the services.

- 1.15.2. If there are no isolating valves readily available to isolate sections of pipe that requires removal, add valves as required. The cost of these valves shall be included in the tender price. Add cap to all valves at the termination point of existing services.

- 1.15.3. Where valves are removed, remove valve tags, revise existing charts and hand tags over to Owner.

1.16. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

- 1.16.1. The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Conditions for all requirements.

.1 All work shall be done in accordance with the approved construction schedule and all specified interim schedules. Contractor must comply with the General Contractor's Construction Schedule.

- 1.16.2. Access to the site is limited to location and time of day. Access to areas of the building is limited to location and time of day. Refer to the General Conditions and conform to all requirements.

- 1.16.3. Refer to the security and protection requirements in the General Conditions and conform to all requirements. In particular no open flames shall be used without prior written approval of the Owner. There shall be no smoking, and the site shall be kept clean at all times.

1.17. ASHRAE 90.1

- 1.17.1. All mechanical equipment shall comply with the minimum efficiency standards set out in ASHRAE 90.1 and the Model National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.

1.18. HOISTING FACILITIES

1.18.1. This Division shall provide its own hoisting facilities.

2. Products

2.1.1. Not Used

3. Execution

3.1.1. Not Used

END OF SECTION 15010

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. NOT USED
3. Execution
 - 3.1. DOCUMENTATION REQUIREMENTS
 - 3.1.1. As the project progresses mark all changes and deviations from that shown on the drawings to the white prints.
 - 3.1.2. Keep drawings up-to-date during construction and in addition to field measurements include change orders, site instructions and all other changes. Drawings shall be available for review at all times.
 - 3.1.3. On completion of the work, forward to the Consultant the set of drawings indicating all such changes and deviations for review by the Consultant.
 - 3.1.4. After the drawings have been reviewed, transfer all as-built mark-ups from prints to the diskettes using latest release of AutoCAD software. Submit prints/plots of drawings after information has been transferred to diskette for review by the Consultant.
 - 3.1.5. Final as-built prints/plots shall not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). Drawings containing mark-ups shall be revised on computer and printed/plotted.
 - 3.1.6. The project will remain incomplete and a holdback will be retained until satisfactory as-built drawings and disks are provided.
 - 3.1.7. The Mechanical Contractor may request from the Consultant the most current mechanical drawings on AutoCAD, IBM PC CD ROM format (at a nominal charge of \$200.00).
 - 3.1.8. The AutoCAD documents shall meet all the Owner's and Consultant's requirements.
 - 3.2. CAD REQUIREMENTS
 - 3.2.1. A complete list of layer names and brief description of each layer's use shall accompany all files.
 - 3.2.2. Fonts for text shall be AutoCAD standard. Custom fonts, shape files, etc., are not to be used.
 - 3.2.3. Final as-built drawings shall be returned on CD ROM.

- 3.2.4. Each CD ROM shall be clearly labelled with Consultant and Owner, Contract number, file names and Drawing number. If a complete listing exceeds the label size provide a "readme.txt" file in ASCII format with each CD ROM. A printed copy of the readme file shall accompany each CD ROM.
- 3.2.5. All drawings shall be in the same units as issued on Bid Documents.
- 3.2.6. Provide a complete list of symbol (block) names with a description of each symbol.
- 3.2.7. Special effort shall be made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.

END OF SECTION 15030

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 2. Products
 - 2.1. SHOP DRAWINGS
 - 2.1.1. Shop Drawings shall be organized by Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned not reviewed.
 - 2.1.2. Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawings shall give the identifying number as noted in the documents of the specific pump, fan, etc. for which it was prepared.
 - 2.1.3. Each Shop Drawing for non-catalogue items shall be prepared specifically for this project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
 - 2.1.4. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: a variable speed motor control – the Consultant may also request that this information be added to the maintenance and operating manual.
 - 2.1.5. Provide a cover sheet with the project name, issue date, issue number, Specification section number, title of section and with space for Shop Drawing review stamps for the Contractor and Consultant.
 3. Execution
 - 3.1. SUBMISSIONS
 - 3.1.1. Each Shop Drawing or catalogue sheet shall be stamped and signed by the Contractor to indicate that he has checked the drawing for conformance with all requirements of the Drawings and Specifications, that he has co-ordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that electrical co-ordination is complete before submitting drawings for review.
 - 3.1.2. Installation of any equipment shall not start until after final review of Shop Drawings by the Consultant has been obtained.
 - 3.1.3. Provide all necessary copies required for the trades, suppliers or other Consultants.
- END OF SECTION 15031

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Include for all cutting and patching for all mechanical services
 - 1.1.3. Where this Section indicates “Structural Consultant” it shall be understood to mean the “Landlord and/or the Landlord’s Structural Consultant”.

2. Products
 - 2.1. MATERIALS
 - 2.1.1. All services and materials used for the cutting and patching shall be carried out by professional workers experienced in the cutting and patching work to be done.

3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Locate all openings in non structural elements requiring cutting and patching in a timely manner to avoid unnecessary cutting. All openings shall be shown on Drawings and submitted to the Consultant for review. No holes through structure shall be permitted prior to review by the Structural Consultant.
 - 3.1.2. Locate existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Core drilling for individual services shall be by this Division. Cut all openings no larger than is required for the services.
 - 3.1.3. Locate all openings in structure elements requiring cutting and patching and x-ray the structure to obtain Structural Consultant’s approval prior to cutting or core drilling of existing structure. Make adjustments to location of openings as required to minimize cutting of rebar and completely avoid electrical conduit.
 - .1 Cut holes through slabs only.
 - .2 Do not cut holes through beams.
 - .3 Holes to be cut are 200 mm (8 in.) (diameter) or smaller only.
 - .4 Maintain at least 100 mm (4 in.) clear from all beam faces. Space at least 3 hole diameters on Centre.
 - .5 For holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.
 - .6 For holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.

- .7 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity.
 - 3.1.4. Cutting and drilling shall only be at locations and times allowed by the Structural Consultant. Obtain written approval by the Structural Consultant prior to core drilling holes or openings. Protect all tenant areas where core drilling occurs.
 - 3.1.5. Patch all openings after services have been installed to match the surrounding finishes.
- END OF SECTION 15080

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Piping and equipment provided under the Mechanical Division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.
 - 1.1.3. Hangers, supports, anchors, guides, and restraints shall be selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. The Mechanical Division shall prepare detailed shop drawings showing all anchors and guides for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. The drawings shall bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and place of work. The drawings shall include all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the project Structural Consultant. Make adjustments as necessary to satisfy the requirements of the Structural Division. No anchor points shall be permitted without reviewed shop drawings and, where installed prior to review, shall be removed and replaced to the satisfaction of the Consultant.
 - 1.1.4. Where this Section indicates “Structural Consultant” it shall be understood to mean the “Landlord and/or the Landlord’s Structural Consultant”.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Provide hangers and supports manufactured by Anvil International or E. Myatt & Co.
 - 2.1.2. All pipe hangers and supports shall be manufactured to the latest requirements of MSS-SP-58. Where applicable, design and manufacture of hangers and supports shall also conform to ANSI/ASME Code for Pressure Piping B31.1.
 - 2.1.3. Pipe rolls shall have cast iron rollers, shaped to accept the outside diameter of the insulated pipe. Roll shall either rotate on a steel shaft mounted on a cast iron stand or shall roll on a cast iron bed plate.
 - 2.1.4. Pipe slide assembly shall be manufactured to the latest requirements of MSS-SP-69. Assembly shall be complete with Carbon steel structural or fabricated tee, 100% virgin PTFE bonded slide plates and carbon steel base.
 - .1 For cold services such as domestic cold water to maintain the integrity of the insulation and vapour barrier and where slides cannot be directly welded to the pipe provide a plain carbon steel pipe clamp to be welded to the tee support. Clamp shall be full length of tee support and shall be minimum 150mm (6 in.) or as recommended by manufacturer for the specific pipe size.
 - .2 For hot services such as heating water, etc. where the piping is 50mm (2 in.) and larger, use a standard catalogue protection saddle tack welded to the pipe, which provides a space between the pipe and tee equal to the thickness of the insulation. Weld the tee to the protection saddle.

- .3 For longitudinal movement only provide hold down lugs.
- .4 For free movement in all directions width of slide plate base shall be sufficient for full travel.
- .5 As an alternative to the above, for compact installations, tees may be welded to the pipe directly provided that the temperature is suitable, extended structural or fabricated tees are used, and the tee is vapour sealed at the insulation and completely insulated to prevent condensation for cold services. Provide details and obtain approval from the Consultant prior to proceeding with this arrangement.

3. Execution

3.1. INSTALLATION

- 3.1.1. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent undue stress to building structural components.
- 3.1.2. Piping shall be supported from walls, beams, columns, and slabs using approved structural attachments. In situations where approved attachments cannot be used, alternative attachments or substructure assemblies shall receive approval prior to installation. Prior approval shall be given for any cutting or drilling of building structural steel. Damage or modification to the structure through welding, cutting, or drilling shall not be permitted if it reduces the integrity of the building structure as deemed by the Structural Consultant. It shall be the responsibility of the Mechanical Division to supply anchor bolts and base diagrams for equipment and pipe supports showing exact location of attachments.
- 3.1.3. All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.
- 3.1.4. Auxiliary structural members shall be provided under the Mechanical Section concerned where piping, ducts or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Auxiliary structural members shall be the same material and finish as the primary structure (i.e. prime painted, galvanized, etc.). Submit details for review as requested.
- 3.1.5. Depending on the type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts. Submit proposed hanger details for review and acceptance by the Structural Consultant. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- 3.1.6. Suspension from metal deck shall not be allowed unless specifically accepted by the Consultant. Drawings of the proposed method of suspension must be submitted for review.
- 3.1.7. Hanger rods shall be subject to tensile loading only. Suspended piping shall be supported by adjustable hanger rods sized as follows:

Pipe Size	Hanger Rod Diameter
50mm (2 in.) and under	9mm (3/8 in.)
65mm (2-1/2 in.) and 75mm (3 in.)	12mm (1/2 in.)
100mm (4 in.) and 125mm (5 in.)	16mm (5/8 in.)
150mm (6 in.)	19mm (3/4 in.)
200mm (8 in.) to 300mm (12 in.)	22mm (7/8 in.)

3.1.8. Unless otherwise specified or shown hanger spacing for all services shall be as follows:

Nominal Pipe Diameter	Maximum Span
Up to and including 25mm (1 in.)	2.1 m (7 ft.)
32mm (1-1/4 in.) to 125mm (5 in.)	3 m (10 ft.)
150mm (6 in.) and larger	4.6 m (15 ft.)

In addition, provide a hanger within 600mm (2 ft.) on each side of valves on pipes over 38mm (1½ in.) diameter, elbows or tees.

3.1.9. Hanger spacing for plumbing and drainage services shall be in accordance with the plumbing code.

3.1.10. Hanger spacing for fire protection services shall be in accordance with the N.F.P.A. codes.

3.1.11. All horizontal piping 50mm (2 in.) diameter and larger shall be supported by adjustable wrought iron clevis type hangers. Smaller piping shall be supported by adjustable split ring hangers or clevis type hangers.

3.1.12. Suspending one hanger from another shall not be permitted.

3.1.13. For hot water piping 38mm (1-1/2 in.) and smaller, use line size hangers.

3.1.14. For cold water services such as domestic cold water (1 in.) and smaller, install a section of high density insulation complete with continuous vapour barrier between the pipe and the hanger. Refer to Section 15250 – MECHANICAL INSULATION.

3.1.15. For cold water services such as domestic cold water larger than 25mm (1 in.), use a galvanized steel shield between the insulation and the hanger. Between the shield and the pipe, install a section of high density insulation complete with continuous vapour barrier. Refer to Section 15250 – MECHANICAL INSULATION.

The shield width shall be minimum 1/4 of the pipe circumference. The length and gauge shall be as follows:

- .1 150mm (6 in.) long and 14 US gauge for pipe larger than 25mm (1in.) up to 50mm (2 in.) diameter
- .2 250mm (10 in.) long and 12 US gauge for pipes 65mm (2-1/2 in.) to 300mm (12 in.) diameter
- .3 300mm (12 in.) long and 10 US gauge for pipes 350mm (14 in.) to 400mm (16 in.) diameter

3.1.16. Hangers and riser clamps in contact with copper pipe shall be copper coated construction or plastic coated. Taped hangers and riser clamps shall not be accepted.

3.1.17. Provide constant support hangers where shown for horizontal or vertical pipes which require vertical movement for expansion. Vertical movement shown for these hangers shall be movement either up or down. Provide hangers to allow for movement in both directions.

3.1.18. Unless otherwise specified or shown, vertical pipes shall be supported at least every fourth floor or every 12 m (40 ft.) maximum.

3.1.19. Pipe slides shall be pre-engineered type. Structural or fabricated tees shall be welded to the pipe or to the protection saddle as shown.

- 3.1.20. Install resilient hangers in accordance with Section 15200 – VIBRATION AND NOISE CONTROL.
- 3.1.21. Other means of support shall be as shown or as specified hereunder.
- 3.1.22. For special equipment supports refer to equipment sections. Where no support method is identified secure wall mounted equipment to metal framing or masonry, with steel toggle or expansion fasteners, machine screws or sheet metal screws as applicable. Plastic, fibre or soft metal inserts shall not be acceptable. Wall mounted equipment shall not exceed 45.5 Kg (100 lbs) in weight or 250mm (10") in depth unless reviewed or detailed by the Consultant. Where framing does not permit direct attachment, provide metal strut sub-framing or minimum 19mm (3/4 in.) fire retardant treated plywood backboards, unpainted, attached to the framing. Provide attachments for backboards at 600mm (24 in.) on centres with no less than 4 attachments.

END OF SECTION 15094

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. QUALITY ASSURANCE
 - 1.2.1. Acceptable balancing companies are limited to the following and shall be approved by the Owner:
 - .1 Design Test
 - .2 Pro-Air Testing
 - .3 VPG Associates
 - .4 Dynamic Flow Balancing Ltd.
2. Products
 - 2.1. NOT USED
3. Execution
 - 3.1. EXISTING SYSTEM VERIFICATION
 - 3.1.1. Prior to commencement of any work, check and verify on site, the total supply air quantity and available static pressure presently available from the main supply air ducts and/or the fan serving the project area and report the test results to the Consultant.
 - 3.1.2. Verify air quantities for all existing VAV boxes, minimum and maximum, including boxes indicated as not having setpoints changed. Confirm the appropriate operation and calibration of all existing thermostats report all deficiencies.
 - 3.2. SYSTEM BALANCING
 - 3.2.1. Balance the complete air system including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition). Test the entire system for noise, tightness of joints and proper functioning of the system. Make noise tests under minimum system pressure drop conditions (highest air velocities and clean filter conditions). Make necessary alterations and repeat the tests until satisfactory operation is achieved.
 - 3.2.2. The Independent Balancing Company measures and reports upon the air volume at each diffuser, register and grille. Report shall also show the final balance position on all noted balancing dampers after final adjustment of air turning and balancing devices. Provide a deficiency report to the Contractor prior to finalizing the testing and balancing report to the Consultant, with all noted deficiencies resolved. Submit three (3) copies of the final air

systems test and balance report to the Consultant. Indicate all test results including coil entering and leaving air temperature, closest and furthest outlet supply air temperatures, and room temperatures for all air systems.

- 3.2.3. Provide assistance to the air balancing company and shall provide control settings, new filters, and other incidentals and equipment required for the measurements.
- 3.2.4. Air volumes measured by the balancing company shall be within plus or minus 5% of those shown on Drawings for diffusers, grilles and registers and within 10% for fans.
- 3.2.5. Adjust all deflection blades on new and existing supply air grilles and diffusers, to ensure that air pattern is horizontal across the ceiling.
- 3.2.6. Include for two additional days (16 hours) of fine tuning as may be required to accommodate tenant specified requirements. This final adjustment may be required any time within the first six months of occupancy.
- 3.2.7. In all cases where measurements by the balancing company show failure to comply with the Drawings and Specifications, engage the balancing company to rebalance the system at no increase to Contract price.
- 3.2.8. The balancing of the air and water systems shall be performed by the same balancing company.

END OF SECTION 15192

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Shop Drawings: Supply Shop Drawings of the vibration and noise control equipment being supplied. Provide Shop Drawings showing completely the various acoustic assemblies.
 - 1.2.2. Report: Submit a report, complete with resultant sound curves to the Consultant substantiating that all equipment has been adequately isolated and that acceptable noise levels exist in the occupied zones.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. All equipment provided for vibration isolation or noise control shall be new and manufactured specifically for the purpose intended.
 - 2.1.2. All vibration isolation devices shall be Vibro-Acoustics, Kinetics Noise Control or Mason Industries and shall be one manufacturer throughout the project.
 - 2.2. SOUND BAFFLES
 - 2.2.1. Sound baffles indicated on the drawing shall be 2 layers of 4.9 kg/sq. m. (1 lb/ sq. ft.) sheet acoustic barrier material installed in the perimeter induction enclosures and centred on adjoining partitions. Seal sheets to enclosure and around all piping etc. inside the enclosures. Cover the acoustic sound barrier sheet with drywall on both sides to ensure the acoustic sheets are encapsulated. Acoustic barrier shall be Kinetics KNM or AcoustiGuard Noise-Blok.
 - 2.3. VIBRATION ISOLATION
 - 2.3.1. Type SPH (Spring Hangers) – Vibro-Acoustics Model SH, Kinetics Model SH, or Mason Industries Model 30
 - .1 Type SPH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
 - .2 Unless otherwise specified, the static deflection of SPH hangers under actual load conditions shall be 50 mm (2 in.).

- 2.3.2. All spring mounts shall be complete with levelling devices 6 mm (1/4 in.) thick ribbed neoprene sound pads and completely colour coded stable springs.
- 2.3.3. Where steel spring isolation systems are described in the specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 80% of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after spring installation.
- 2.3.4. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.
- 2.3.5. All vibration isolators shall have either known undeflected heights of calibration markings to that, after adjustment, verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to design.
- 2.3.6. Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses; "Embeco 636 Grout", "Imperial Grout", or "Sauereisen F-100".
- 2.3.7. Acoustic Sealant: Non-hardening, non-skinning permanently flexible, to CAN/CGSB-19.21-M87. Tremco, CGC Acoustic Sealant or approved equivalent.
- 2.4. INTERNAL ACOUSTIC DUCT LINING
- 2.4.1. Fiberglass duct liner shall be manufactured by Certainteed, Owens-Corning, Knauf Insulation, or Johns Manville.
- 2.4.2. Natural fibre duct liner shall be manufactured by Bonded Logic.
- 2.4.3. Duct lining shall have a minimum density of 24 kg/m³ (1.5 lbs/ft³).
- 2.4.4. Duct liner shall comply with the requirements of NFPA 90A and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturer's Association.
- 2.4.5. Sizes shown on the Drawing are free area dimensions (after the installation of duct liner). Duct liner shall be a minimum of 25 mm (1 in.) unless shown otherwise.
- 2.4.6. All acoustical duct lining shall incorporate means to prevent fiber entrainment in the air stream.
- 2.4.7. The following ductwork shall be internally lined:
- .1 All return air transfer ductwork.
 - .2 All ductwork specifically identified on the Drawings.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Obtain one copy of all Shop Drawings of equipment to be isolated showing weights, shaft centres and all dimensions.
- 3.1.2. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 6mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.

- 3.1.3. Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.
- 3.1.4. All wiring connections to mechanical equipment on isolators shall be made with a minimum long flexible conduit installed in a slack “U” shape.
- 3.1.5. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
- 3.1.6. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
- 3.2. EQUIPMENT ISOLATION
- 3.2.1. The first isolator both upstream and downstream of equipment on springs shall have a static deflection of 1.5 times the deflection of the vibration isolated equipment to a maximum of 50 mm (2 in.). All other piping supports shall have a static deflection of 25 mm (1 in.) minimum.
- 3.2.2. No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.
- 3.2.3. Any conflicts with other trades which result in rigid contact with the equipment or piping due to inadequate space or other unforeseen conditions should be brought to the Consultant’s attention prior to installation. If not brought to the attention of the Consultant prior to installation corrective work necessitated by conflicts shall be at the Contractor’s expense.
- 3.2.4. Locate isolation hangers with the housing a minimum of 50 mm (2 in.) below but as close as possible to the structure. Where isolator hangers would be concealed by a non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.
- 3.2.5. After installation, manufacturer shall verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that the isolators are adjusted, with springs perpendicular to bases or housings, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.
- 3.3. ACOUSTICAL LINING OF DUCTS
- 3.3.1. Ducts, except where noted otherwise, shall be acoustically lined internally, from the fan connection to the terminal. Both supply and return systems shall be lined unless otherwise specified. Exhaust ducts shall be internally lined where shown on the Drawings to reduce sound transmission.
- 3.3.2. Other ductwork shall be acoustically lined where shown on the Drawings.
- 3.3.3. Acoustical duct lining shall be 50 mm (2 in.) thick in ducts within Mechanical Rooms, in plenums, and where expressly shown on the Drawings. Acoustical duct lining shall be 25 mm (1 in.) thick in all other internally lined sheet metal ducts, unless otherwise specified or shown on the Drawings.
- 3.3.4. The acoustical liner shall be fixed to the duct with a minimum of 50% coverage of a fire-resistant adhesive. Where the duct width exceeds 300 mm (12 in.) or the height 600 mm (24 in.), the liner shall be additionally secured with mechanical fastening on maximum 450 mm (18 in.) centers on all sides. Mechanical fasteners that pierce the duct are unacceptable. Mechanical fasteners shall be in accordance with Section 15250 – MECHANICAL INSULATION. All ends of the liner shall be coated with a fire resistant cementing material to

prevent delamination, leakage or erosion. All joints shall be firmly butted and ends coated with an adhesive to ensure that the lining is smooth across all joints.

- 3.3.5. Where acoustical duct lining is installed, the dimensions of the sheet metal shall be increased to include the thickness of the lining material. Dimensions shown on the Mechanical Drawings are the clear internal dimensions after the liner has been installed.

END OF SECTION 15200

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Provide shop drawings with technical data on all types of insulation to be installed.
 - 1.1.3. Provide samples of each type of insulation indicating where each is to be used and a sample of a typical vapour barrier dam. Samples shall be mounted on boards and shall be kept at the Contractor's site office.

2. Products
 - 2.1. MATERIALS
 - 2.1.1. Fibreglass insulation shall be Owens-Corning, Certainteed, Manson, Johns Manville, Knauf or Fibrex.
 - .1 Duct insulation shall be rigid board vapour seal 48 kg/cu.m. (3 lbs/cu.ft.) density duct insulation with factory applied vapour barrier. Flexible duct insulation shall be 24 kg/cu.m. (1-1/2 lbs/cu.ft.) type with vapour barrier.
 - .2 Pipe insulation shall be preformed sectional fibreglass or mineral fibre insulation with factory applied all service jacket.
 - 2.1.2. Foamglass insulation shall be Pittsburgh-Corning.
 - 2.1.3. Flexible elastomeric insulation shall be Armacell or Nomaco with adhesive applied to both surfaces to be joined. Flexible elastomeric insulation shall not be used on pipes that are electrically traced.
 - 2.1.4. High temperature insulation shall be 232 kg/ cu.m. (14.5 lbs/cu.ft.) Johns Manville Thermo-12 Gold molded, asbestos free, non-combustible, abuse-resistant pipe and block insulation composed of hydrous calcium silicate meeting ASTM C533, Type I for operating temperatures up to 649 Deg. C. (1200 Deg. F.).
 - .1 Tie Wire shall be 16 gauge (0.045mm) stainless steel with twisted endons on maximum 300mm (12 in.) centres.
 - 2.1.5. High temperature insulation shall be Roxul SturdiRock molded, non-combustable, mineral wool fibre pipe insulation.
 - 2.1.6. Corner beads and channels at floor line shall be 0.4 mm (28 ga.) galvanized sheet metal.
 - 2.1.7. Fire retardant lagging coating shall be Chil-Seal CP-50 by Childers Products Company or Monsey Bakor equivalent.
 - 2.1.8. Vapour barrier dam shall be Chil-perm CP30 with fibreglass cloth reinforcing.
 - 2.1.9. All cements and adhesives shall be as recommended by the manufacturer of the insulation. Insulation, insulation jacket, canvas and adhesive shall be fire retardant with a flame spread

rating not to exceed 25 and a smoke developed rating not to exceed 50 when tested in accordance with CAN/ULC-S102-M.

- 2.1.10. P.V.C. fitted jackets and covers shall have a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 when tested in accordance with CAN/ULC-S102-M.
- 2.1.11. Aluminum Jacket shall be 0.51mm (24 B&S Guage - 0.0201 in) this sheet, embossed finish, with longitudinal slip joints and 50mm (2 in.) laps, die shaped fitting covers with factory applied moisture barrier.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install insulation in accordance with the manufacturer's printed installation instructions unless noted otherwise.
- 3.1.2. Insulation thicknesses and conductivities shall meet or exceed the minimum standards set out in ASHRAE 90.1 (refer to Table 1 following) and as specified herein for the services covered.
- 3.1.3. Apply insulation to clean, dry surfaces only while ambient temperature is at least 10 deg. C. (50 deg. F.).
- 3.1.4. Commence application of insulation following required testing of piping, ductwork, and apparatus where such items are to be covered.
- 3.1.5. Recover all insulation, where exposed to view and not concealed in ceiling spaces or pipe spaces with 6 oz. canvas pasted on. Apply two coats of fire retardant lagging finish.
- 3.1.6. Where approved by the Consultant, as an alternative to the above, recover all piping insulation with a PVC jacket and preformed PVC elbows and fittings sealed with adhesive. PVC shall not be used on steam, medium and high temperature hot water piping or piping services that will be painted.
- 3.1.7. Cover all piping insulation external to the building and where specifically shown with field applied mesh reinforced mastic.
- 3.1.8. Where vapour barrier dams are called for, terminate the insulation and seal the vapour barrier to the pipe or ductwork using a mesh embedded in a vapour barrier mastic. Provide dams at valves, fittings used for servicing, groups of other types of fittings, irregular shaped objects at floor and wall penetrations, and at 15 m (50 ft.) intervals of straight pipe or straight ductwork for the following services: water piping that is less than 80 deg. F., including but not limited to the following:
 - .1 Domestic cold water piping
- 3.1.9. Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.
- 3.1.10. Irregular shaped objects such as strainers, pipe system filters, cyclone separators, blowdown valves and other accessories requiring servicing, on insulated piping, shall be insulated with removable caps or sections. All edges shall be sealed between pipe and vapour barrier and held in place with stainless steel straps. Finish all insulation smooth, making the outline of pipe insulation a true circular and concentric shape. Shape the outline of fitted insulation to blend with adjacent covering.

- 3.1.11. On piping systems specified to be insulated, include insulation on valves, flanges, couplings and unions.
- 3.1.12. Do not use staples to secure joints of insulation jackets.
- 3.1.13. Apply bands to concealed pipe insulation on max. 600 mm (24 in.) centres.
- 3.1.14. Hot Services
- .1 Heating water services shall have glass fibre preformed pipe insulation. Refer to Table 1 for required insulation thicknesses.
 - .2 On hot services, insulate valves, fittings, couplings, unions, flanges and all other appurtenances through which water or steam passes, using mitred sections of preformed insulation of a thickness equal to the adjoining pipe insulation, and securely wire in place. Over mitred section, apply one coat of field applied mesh reinforced mastic. Finish services with a vapour barrier using two full brush coats of vapour seal adhesive. Cover with canvas or PVC jacket.
 - .3 Apply glass fibre or mineral fibre preformed vapour barrier jacket pipe insulation to domestic hot water piping. Refer to Table 1 following for required insulation thickness. Apply with all joints butted firmly together, and bond securely, sealing flaps by pasting down to give a smooth finish.
- 3.1.15. Cold Services
- .1 For domestic cold water piping less than 75 mm (3 in.) where hangers on cold water lines penetrate vapour barrier make sure the penetration is properly sealed with insulation and vapour barrier continued up hanger a further 75 mm (3 in.).
 - .2 Where sheet metal shields are used refer to Section 15094 – HANGERS AND SUPPORTS.
 - .3 Apply 12 mm (1/2 in.) thick, preformed glass fibre pipe insulation with vapour barrier jacket or 12 mm (1/2 in.) thick flexible elastomeric insulation to all domestic cold water and chilled drinking water piping. Insulate the first 4500 mm (15 ft.) of the standpipe and/or sprinkler main.
 - .4 On cold water service valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges and other irregular shaped objects, apply flexible elastomeric sheet insulation, thickness to suit service, cut and mitre as necessary, and attach with adhesive and stainless steel banding. Bond and seal edges of insulation to the adjacent surfaces and finish with field applied mesh reinforced mastic.
- 3.1.16. Drainage Piping
- .1 Cover cast iron bell and spigot drainage pipe 75 mm (3 in.) and smaller with 12 mm (1/2 in.) preformed glass fibre pipe insulation, and finish with vapour barrier jacket. Cover the bell and spigot joint with a 12 mm (1/2 in.) thick flexible elastomeric insulation band that overlaps the fibreglass insulation 300 mm (12 in.) beyond joint in each direction. Seal band to the fibreglass insulation. Apply 25 mm (1 in.) thick insulation for all larger pipes.
- 3.1.17. Ductwork and Equipment
- .1 Ductwork and equipment internal to the building within conditioned spaces shall have 25 mm (1 in.) thick rigid glass fibre duct insulation with vapour barrier. In concealed spaces and on round duct smaller than 600 mm (24 in.) insulation may be 38mm (1-1/2 in.) flexible type with vapour barrier. Flexible duct connections do not require insulation except where a factory applied insulation has been specified with the flexible duct connection.

- .2 Butt join insulation and attach with pins and speed washers, one per 0.186 sq.m. (2 sq.ft.), but not more than 450 mm (18 in.) apart in any direction. Apply fire resistive adhesive in 100 mm (4 in.) wide strips on 300 mm (12 in.) centres. Seal all joints with adhesive and apply vapour barrier tape. Install pins of suitable length for the thickness of insulation and clip flush after final installation of washers. Tack weld pins to sheet metal.
 - .3 Insulation Contractor to coordinate with sheet metal contractor to ensure duct insulation is applied prior to ductwork being installed to underside of slabs, beams or other services or behind other duct risers and shafts.
- 3.1.18. The following ductwork and equipment shall be insulated:
- .1 Exhaust ductwork.
 - .2 All supply ductwork from fans to take-off for VAV box for variable volume systems and all supply ductwork on constant volume systems.
- 3.1.19. Make good all existing insulation when connecting to existing services (where damaged). Where existing insulation has been previously removed, or is in a state of disrepair, bring this item to the Consultant's attention.

3.1.20. TABLE 1: MINIMUM PIPE INSULATION THICKNESS/PERFORMANCE (BASED ON ASHRAE 90.1 AND MODEL NATIONAL ENERGY CODE FOR BUILDINGS)

Minimum Pipe Insulation – mm (in.)

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity [W(m-K)] [h-cu.ft. – deg. F. (Btu-in.)]	Mean Rating Temp deg. C. (deg. F.)	Nominal Pipe Diameter – mm (in.) Runouts ^b Up to 50 (2)	Nominal Pipe Diameter – mm (in.)				
				25 (1) and less	32-50 (1-1/4 to 2)	65-100 (2-1/2 to 4)	125-150 (5-6)	200 (8) and up
Domestic and Service Hot Water Systems ^c								
41 and greater (105) and greater	0.040 (0.28)	38 (100)	25 (1.0)	25 (1.0)	25 (1.0)	38 (1.5)	38 (1.5)	38 (1.5)

Piping installed exterior to the building shall meet the minimum insulation requirements of Heating Systems with a fluid design operating temperature above 177 Deg. C. (350 Deg. F.).

^b Runouts to individual terminal units not exceeding 3.7 m (12 ft.) in length

^c Applies to recirculating sections of service or domestic hot water systems and first 2.4 m (8 ft.) from storage tank for non-recirculating systems.

END OF SECTION 15250

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Pipes and fittings shall be in accordance with the following unless specified otherwise by local authorities.
 - 2.1.2. All city and domestic water, above grade, 75 mm (3 in.) and smaller, less than 1380 kPa (200 psi) working pressure:
 - .1 Pipe: Copper Tubing, Type “L”, Hard Drawn, ASTM B88. Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18.
 - .2 Joints made with 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, ASTM B32.
 - .3 Grooved end copper fittings conforming to ASTM B75 etc.
 - .4 Couplings to be designed with angle bolt pads to provide a rigid joint.
 - .1 Installation ready for direct stab installation without field disassembly, complete with grade EHP gasket, rated for -35 deg. C. to 121 deg. C. (-30 deg. F. to 250 deg. F. Victaulic 607.
 - .2 Copper tubing standard coupling complete with EPDM flush seal gaskets rated for -35 deg. C. to 110 deg. C. (-30 deg. F. to 230 deg. F.) Victaulic 606.
 - .5 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, rising stem screwed. Crane #428, Jenkins #810J, Toyo 293 or Kitz 24, for threaded ends or Crane #1334, Jenkins #813J, Toyo 299 or Kitz 44 for solder ends.
 - .6 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, solder ends or with screwed to solder adapter and composition disc for water service. Crane #1310, Jenkins #106BPJ, Toyo 222 or Kitz 10.
 - .7 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, swing check, solder ends. Crane #1342, Jenkins #4093J, Toyo 237 or Kitz 23.
 - 2.1.3. Sanitary drains and vents above grade shall be cast iron or copper pipe installed as in regulations, except where copper pipe is used, joints to be made with 95-5 solder. ABS and PVC pipes are not acceptable.
 - 2.1.4. Butterfly valves may be used in lieu of gate valves in size 65 mm (2-1/2 in.) and over in systems 1380 kPa (200 psi) and less. Where specifically shown on drawings, butterfly valves must be used. Install between 860 kPa (125 psi) flanges.
 - .1 Valves shall have iron body, one piece or split alloy steel shaft, top and bottom bearings, bronze disc or iron disc with stainless steel trim and resilient elastomer replaceable seat with integral reinforcing ring or keyed to body.

- .2 Body shall have threaded lugs.
 - .3 Valve shall have bubble tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
 - .4 Valves 100 mm (4 in.) and smaller shall have lever operator with lock.
 - .5 Valves larger than 100 mm (4 in.) shall have worm gear manual operator with indication of valve opening.
 - .6 Butterfly valves shall be equal to Keystone Model 222-784, Dezurik Model BGS, Challenger Model 20-CN4E, Bray Series 31, Apollo 143 Series, Kitz 61 Series, Centreline 200 or Crane 44.
 - .7 Butterfly valves for grooved end systems shall be Victaulic 608.
- 2.1.5. Back-flow preventers for connection to wall hydrants, hose bibbs, hot water heating systems, and similar uses, shall be Watts No. 9 or 909 or Hersey-Beeco with C.S.A. listing.
- 2.1.6. Ball valves 50 mm (2 in.) and smaller shall be bronze body or forged brass 4137 kPa (600 psi) WOG, virgin Teflon seat, TFE stem packing and thrust washer, 1/4 turn open-closed operation with solid ball. Ball valves shall be Watts No. B-6000, Toyo 5044A/5049A, Kitz 58/59 or Apollo 70-100/200. Stem extensions shall be provided on all ball valves. Ball valves may be substituted for gate valves only.
- 2.1.7. Except where special feature are required or unless otherwise approved or noted, all valves shall be of one manufacturer with the manufacturer's name and the pressure rating clearly marked on the outside of the valve body. Valves shall be manufactured by Crane, Jenkins, Toyo or Kitz. Butterfly valves shall be by Keystone, DeZurik, Bray, Challenger, Centerline, Crane, Apollo, Kitz or Victaulic. Non-slam check valves shall be Pro-Quip, Duo CHEK II, Centerline, Mueller or Victaulic. Ball valves shall be Apollo Watts, Crane, Jenkins, Toyo or Kitz. Valves shall be equal to the model numbers specified.
- 2.1.8. Gate valves in sanitary drains shall be equal to Seguro rubber sealed, cast iron, Class 150, ASA B16.10, with ASA B16.1 flanged ends, with OS&Y rising stem operation.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Valves shall be provide as shown and as required for the satisfactory operation and control of all equipment and shall be installed to enable each piece of equipment to be isolated.
- 3.1.2. Gate valves shall be installed at the base of each riser and at each branch take-off. Where the equipment is to be isolated within easy view of and not more than 6000 mm (20 ft.) from the main, at the branch take-off, then the branch take-off valve may serve as the equipment isolating valve.
- 3.1.3. Drain valves shall be installed at each low point in the piping systems and at each tank.
- 3.1.4. Blow-off valves shall be provided on each 65 mm (2-1/2 in.) strainer and larger.
- 3.1.5. Globe valves shall be installed as shown and in each bypass.
- 3.1.6. Check valves shall be installed as shown and where required to prevent backflow.

- 3.1.7. The following publications shall be used to establish class of bedding and class of piping for installation other than the above. They shall also serve as guide for preparation of bedding, installation and testing.
- .1 Cast iron soil pipe and fittings handbook of the cast iron soil pipe institute.
 - .2 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Manville.
- 3.1.8. Connections between copper and steel pipe shall be made with brass or bronze fittings where other type of connection is not specified in regulations.
- 3.1.9. All piping shall run parallel with closest wall.
- 3.1.10. Piping in walk-in pipe spaces shall be installed as close to one wall as possible.
- 3.1.11. Slope all drains and vents in accordance with the plumbing code but not less than the minimum slopes shown on the drawings. Slope all water lines 25 mm in 12 m (1 in. in 40 ft.) unless shown otherwise.
- 3.1.12. Vent stack covers shall be properly sized for each vent penetrating the roof. Division 15 shall supply vent stack covers for installation and flashing by the roofing contractor.
- 3.1.13. Provide a thermostatic mixing valve on discharge of domestic hot water systems.

END OF SECTION 15410

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 2. Products
 - 2.1. MATERIALS
 - 2.2. FINISHED AREAS
 - 2.2.1. Cleanouts in finished areas with membrane floors shall be coated cast iron body with adjustable nickel bronze frame and round scoriated gas tight access cover with secondary gas tight plug. J.R. Smith 4020-F-C, Zurn ZN 1400-KC, Mifab C1100C-R-1-34, Watts CO-100-C-R-1-34G
 - 2.2.2. Cleanouts with recess for terrazzo shall be similar to cleanouts in finished areas with membrane floors but shall have terrazzo recess. J.R. Smith 4180-F-C, Zurn ZN 1400-Z-KC, Mifab C1100C-UR-1-34, Watts CO-100-C-U-1-34G.
 - 2.2.3. Cleanouts with recess for tile shall be similar to cleanouts in finished areas with membrane floors but shall have 3 mm (1/8 in.) tile recess. J.R. Smith 4140-F-C, Zurn ZN 1400-X-KC, Mifab C1100C-UR-1-34, Watts CO-100-C-T-1-34G.
 - 2.2.4. Cleanouts for carpeted areas shall be similar to cleanouts in finished areas but shall have stamped stainless steel carpet marker. J.R. Smith 4020-Y, Zurn ZN 1400-CM, Mifab C1100-RC-1-34, Watts CO-200-RC-1-34G.
 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Cleanouts in furred ceiling spaces shall extend up through floor slab above, except where the Consultant gives specific approval to its location in the ceiling space.
 - 3.1.2. Cleanouts shall be installed in horizontal drains at each change of direction and as required.
- END OF SECTION 15423

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 2. Products
 - 2.1. MATERIALS
 - 2.1.1. Domestic electric hot water heaters shall be A.O. Smith, and shall be CSA approved.
 - 2.1.2. Tank shall be glass lined steel, factory insulated and covered with an enamelled steel jacket. Tank shall be for 860 kPa (125 psi) working pressure.
 - 2.1.3. Heater elements shall be electric immersion type located at the top and bottom of the tank and shall be complete with thermostats. Elements shall be arranged to operate alternatively or simultaneously, as shown. An additional high limit thermostat shall prevent overheating. Access panels in jacket shall provide access to thermostats and elements.
 - 2.1.4. Tanks shall be complete with A.S.M.E. temperature pressure relief valve. Relief valve shall be piped to nearest funnel floor drain, Janitors Sink, or 1-1/2 in. drain tail piece connected to a sink waste, through an air gap.
 - 2.1.5. Tanks shall be complete with side connections only.
 - 2.1.6. Size of tanks and capacity of heaters shall be as shown.
 - 2.1.7. 'HWT-2.1' - DEL-20, 20.0 imp gal. tank storage 3000 W @ 208V/1N/60 Hz (22.25 in. x 21.75 in. high).
 - 2.1.8. Execution
 - 2.2. NOT USED
- END OF SECTION 15425

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to the Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Refer to Laboratory Furniture and Fittings section for supply, installation, connection requirements for laboratory systems.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Plumbing fixtures shall be as indicated and specified with all required supports, accessories, drainage, vent and water connections to make the fixtures complete.
 - 2.1.2. The flow rates of fittings that supply water to a fixture shall not exceed the maximum flow rates listed in Part 7 of the O.B.C. under the Water Efficiency section.
 - 2.1.3. Fixtures shall be American Standard, Crane, Eljer or Kohler, equivalent to the fixtures specified. Fixtures shall be white.
 - 2.1.4.
 - 2.1.5. Fittings and trim shall be American Standard, Crane, Delta/Cambridge, Kohler, Sloan, Chicago Faucets, Symmons, or Moen equivalent to the trim specified. All exposed valves, fittings, escutcheons, trim, etc., at each fixture shall be polished chrome plated brass unless specified otherwise.
 - 2.1.6. Carriers shall be furnished for all wall hung water closets, urinals, and lavatories. Carriers shall be in conformance with Section 15451 – FIXTURE CARRIERS.
 - 2.2. GENERAL SINK UNITS
 - 2.2.1. **Franke Commercial #ALBS6806P-1/3 Single Bowl Countertop Mount Sink**, 3 holes, 8" (203 mm) center, 508 mm (20") wide x 521 mm (20-1/2") long x 152 mm (6") high deep, counter mounted, backledge, grade 18-10 18 GA. (1.2 mm) type 304 stainless steel, self-rimming, satin finish rim and bowls, mounting kit provided, fully undercoated to reduce condensation and resonance, factory applied rim seal, 3-1/2" (89 mm) crumb cup waste assembly with 1-1/2" (38 mm) tailpiece.
2300-8ABCP Chicago Faucets Marathon #2300-8ABCP Single Handle Faucet, chrome plated finish, 8" (203 mm) deck plate, ECAST construction lead free (equal or less than

0.25%) bronze construction with one piece concealed rough body, ceramic volume control and Hot Water Limit Stop cartridge, 8.3 LPM (2.2 GPM) pressure compensating Softflo aerator outlet, 254 mm (10") projection cast brass swing spout, 117 mm (4-5/8") single metal lever handle with blue and red temperature indicator. **McGuire #LFH165LKN3 Faucet Supplies**, chrome plated finish polished brass, heavy duty angle stops, 10 mm (3/8") I.P.S. Inlet x 76 mm (3") long rigid horizontal nipples, V.P. Loose keys, escutcheon and flexible copper risers. **McGuire #8912CB P-Trap**, heavy cast brass adjustable body, with slip nut, 38 mm (1-1/2") size, box flange and seamless tubular wall bend. **McGuire PROWRAP #PW2000 Sanitary Covering vandal-resistant**, flexible seamless moulded closed-cell PVC resin, formulated with anti-microbial additive to limit the growth of fungus and bacteria, to exposed piping (to protect against heat/contusions) as per local codes.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide necessary plates, brackets, cleats, supports, etc, for rigidly securing fixtures in place. Accurately lay out all roughing piping, avoiding offsets.
- 3.1.2. Examine fixtures for defects. Remove and replace any fixture which, in the opinion of the Consultant, is damaged. Make necessary adjustments to ensure fixtures function as per manufacturer's operating criteria. Clean and polish all fixtures and trim upon completion.
- 3.1.3. Ensure wall-mounted fixtures with back water connections have an adjacent access door, unless the pipe space is sufficiently wide to allow the water connection to be made from within the pipe space. For this, pipe space shall be 600 mm (24 in.) minimum clear width.
- 3.1.4. Fixtures shall be installed symmetrical with wall tile pattern, unless otherwise dimensioned or shown on Architectural Drawings.
- 3.1.5. Final location of all new plumbing fixtures shall be co-ordinated, on-site with all trades. Refer to Architectural,/Interior Design drawings and details for exact location of all plumbing fixtures.
- 3.1.6. Relocate existing fixtures where shown. Dismantle, store and re-install fixtures and brass. Provide all necessary materials to complete the installation in the new location.

END OF SECTION 15450

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Sprinkler system shall conform to applicable N.F.P.A. Standards and to all authorities requirements.

1.2. DESCRIPTION OF SYSTEM

- 1.2.1. The sprinkler systems shall be wet type as shown, consisting of distribution and interconnecting piping, sprinkler heads, hangers, flush and test connections, sprinkler riser, pressure reducing valves, alarm check valves, dry alarm valves, supervised valves, drain valves, sprinkler pumps and controls, excess pressure pump, fire department connections, water motor gong, air compressors, and all necessary equipment to provide a complete sprinkler system ready for immediate operation.
- 1.2.2. Sprinkler system shall connect to water supply where shown on drawings.

1.3. DENSITY AND AREA REQUIREMENTS

- 1.3.1. The following minimum density and area requirements shall be the basis of the hydraulic design. Any request for modifying the density requirement shall be submitted by the Contractor for review by the Consultant.

Location Served	Hazard	Density L/m/sq. m. (gpm/sq. ft)	Area Sq. m. (sq. ft)	Remarks
Office Areas	Light	4.1 (0.10)	139.5 (1500)	Wet Type. Loop main shall have the capacity to serve 5 additional sprinkler heads at the most remote 139.5 sq.m. (1500 sq.ft.) area of application.

- 1.3.2. Where quick response sprinkler heads are used in the design, the area of protection shall not be reduced. Quick response heads shall be provided where required in accordance to NFPA 13.

1.4. SUBMITTALS

- 1.4.1. Shop Drawings: Submit sprinkler drawing layouts in accordance with Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS showing all component parts complete with Shop Drawings of all pumps, starters, valves and accessories to I.A.O. (F.M.) and to the Consultant for review. These drawings shall be designed and bear the signed stamp of an engineer licensed to --practice in the appropriate discipline and in the Place of Work.

- .1 Clearly indicate on sprinkler layout drawings the location of all drain connections.
 - .2 Prepare complete sprinkler layout drawings, arranging piping runs and sprinkler heads in proper relation with bus ducts, air conditioning ducts, piping, etc., and to ensure clear ceiling heights indicated on the drawings. Where piping occurs in ceiling spaces, keep piping above level of top of lighting fixtures.
- 1.4.2. Submit hydraulic calculations in approved formats.
- 1.4.3. Samples: Submit samples of all hangers for review.
- 1.4.4. Operating and Maintenance Instructions:
- .1 Supply three approved hard covered loose-leaf binders containing three complete sets of manufacturer's operating and maintenance instructions, showing all major equipment, control valves, wiring diagrams and schematics, and apparatus requiring maintenance. Spare part suppliers, lists and addresses shall be supplied. Instructions shall be reviewed with the Owner to ensure a through understanding of the equipment and its operation.
 - .2 At the completion of the installation submit a complete set of CADD Record Drawings as outlined in Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS. Record Drawings shall be complete including all valve tag numbers and symbols.
- 1.4.5. Spare Parts: Provide spare heads as follows:
- | Number of Heads of a Particular Type Used | Number of Spare Heads of each Type to be Provided |
|---|---|
| 0 to 299 heads | 6 spares |
| 300 to 1000 heads | 12 spares |
| Over 1000 heads | 24 spares |
- 1.5. QUALIFICATIONS
- 1.5.1. The installation company shall be a member of the Canadian Sprinkler Association and regularly engaged in this work.
2. Products
- 2.1. MATERIALS
- 2.1.1. General:
- .1 All components used in the sprinkler system shall be U.L.C. listed. UL or FM listed equipment not bearing a U.L.C. listing shall only be acceptable if written approval from the local authority is obtained.
 - .2 All components used in the sprinkler system shall be manufactured in Canada or USA, whenever available.
- 2.1.2. Pipe, valves and fittings less than 1206 kPa (175 psi) working pressure shall be as follows:
- .1 Pipe, black steel, Schedule 40, A.S.T.M. A53.

- .2 Fittings for a minimum of 1206 kPa (175 psi) working pressure, 1035 kPa (150 psi) malleable iron ASME B16.3, 860 kPa (125 psi) cast iron ASME B16.4, butt welding schedule 40 ASME B16.25, or roll grooved Victaulic, Gruvlok or Tyco.
 - .3 All grooved products including couplings, fittings and valves shall be of one manufacturer.
 - .4 Fittings with grooved connections at all legs of the fitting or couplings, shall be equal to Victaulic 920, Tyco/Central Figure 730, or Gruvlok Figure 7045 Clamp-T will be accepted. Fittings and couplings that are not acceptable are ones equal to Victaulic 921, Tyco/Central Sprinkler Strap 40-5, or Gruvlok Figure 7045 U-bolt.
- 2.1.3. No grooved fittings or products shall be used except for those specified. All grooved products shall be of one manufacturer.
- 2.1.4. Provide approved type backflow prevention complete with supervised valves, on glycol loops.
- 2.1.5. The pressure reducing valves on the sprinkler down-feed riser shall be hydraulically operated globe valve with U.L.C. label rated at 1206 kPa (175 psi) working pressure. Valves to be sized for maximum 69 kPa (10 psi) pressure drop at 31.5 L/s (500 USGPM) flowing. Singer 106-PR-8702 or Cla-val 90G-21.
- 2.1.6. Pressure reducing valve stations shall consist of two valves each sized for 100% flow in parallel each with supervised isolating valves to permit servicing. All isolating valves on sprinkler system shall be located not higher than 1828 mm (72 in.) above the floor.
- 2.1.7. Alarm flow switches shall be U.L.C. approved and equal to Potter VSR-F. Wiring to annunciator panel shall be by the Electrical Division – Division 16.
- 2.1.8. Switches for supervised valves shall indicate a trouble when valve not fully open. Switch shall be complete with contacts for alarm and supervision. All wiring to annunciator panel shall be by the Electrical Division – Division 16. Plug in type switches are not acceptable. Switches shall be equal to Potter OSYSU.
- 2.1.9. Alarm check valve shall be complete with all appurtenances including contacts for wiring to the building fire alarm system for low pressure and flow, water gong mounted where shown or directed, electric alarm bell mounted where shown or directed, and all valve, gauges, fittings and drains. Victaulic Series 751 Firelock, Tyco AV-1-175/AV-1-300, or Viking Model J-1.
- 2.1.10. Excess pressure pump shall be capable of raising the system pressure 517 kPa (75 psi) above the city water pressure. Capacity shall be 0.12 L/s (2 USGPM) when driven by a 0.25 kW (1/3 hp) motor. Pumps shall be mounted on a bracket adjacent of the alarm check valve. Pumps shall be automatic start/stop from pressure switch set to start at 760 kPa (110 psi) and stop at 830 kPa (120 psi). Provide a trouble alarm to show loss of excess pressure.
- 2.1.11. Pressure switches shall be U.L.C. listed and shall alarm on low pressure in system. Pressure switches shall be suitable for wet systems, dry systems or pre-action systems as applicable. Potter PS40A or PS120A as applicable.
- 2.1.12. Pressure gauges shall be 6 mm (1/4 in.) NPT, (3-1/2 in) dial, 1207 kPa (175 psi) working pressure.
- 2.1.13. Sprinkler heads shall be the automatic spray type, U.L.C. listed and as approved by I.A.O. or F.M. as applicable. Where heads are located close to heating coils, unit heaters or other hot equipment, they shall be of the high temperature type to suit regulations.

-
- 2.1.14. New pendant, upright, concealed or semi-recessed sprinkler heads shall match existing sprinkler heads and shall conform to the base building standards and specifications. Sprinkler heads shall be Reliable, Viking Microfast, Tyco/Central, or Victaulic.
 - 2.1.15. Provide extended coverage sprinkler heads only as required by N.F.P.A. to satisfy general sprinkler head layouts as shown without reducing the area of protection.
 - 2.1.16. Unless otherwise specified, hangers shall conform to the requirements of N.F.P.A. 13.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Spacing of sprinklers shall suit the hazard of the occupancy shown. Where specific locations of sprinkler heads have been shown on Drawings, these shall be maintained. Sizing of piping shall be based on hydraulic design. Submit all calculations to the city, the Owner's Insurers and the Consultant for review. The calculations shall be designed and bear the signed stamp of the engineer.
 - 3.1.2. Pipe sizing where shown on the Drawings is to assist in design, layout and coordination. Ensure that the sizing is correct for the design criteria. Pipe sizes can also be decreased from those shown except where indicated as a minimum size, provided it meets all codes and I.A.O. or F.M. approval.
 - 3.1.3. For exposed structures the sprinkler head layout, where shown, is to assist in design, layout, and coordination. Ensure that all heads required to suit as-built beam, ducts or other obstructions are provided. Where specific pipe locations have been indicated these shall be maintained.
 - 3.1.4. Provide listed sprinkler guards for all heads where required.
 - 3.1.5. Supply and install where directed spare heads and any special types of wrenches in a cabinet.
 - 3.1.6. Installation shall conform to all applicable codes.
 - 3.1.7. Review all other Sections of the Specifications and include for all work that may affect this section. Pay particular attention to the requirements for valve tags and identification.
 - 3.1.8. Fully coordinate the sprinkler piping with that of other trades on the job. Mains and branches shall be run so as not to interfere with the building's structure, electrical, plumbing, ventilation and heating installations. Sprinkler heads shall be located in the centre and/or quarter points of ceiling tile as shown on the reflected installation of additional sprinkler heads.
 - 3.1.9. Co-ordinate with the plumbing trades to ensure proper connections and drains are available. This Section shall pay for any costs associated with ensuring proper drainage is provided.
 - 3.1.10. Provide all alarm and trouble points as required by code and coordinate with the fire alarm annunciator supplier and installer to ensure all points are included in the annunciator.
 - 3.1.11. In areas where existing ceilings are being replaced, remove and replace the sprinkler heads or escutcheon rings as required. If ceiling levels are being changed, relocate sprinkler heads to the new ceiling level.

- 3.1.12. All new sprinkler heads added to the floor because of increased requirements, shall be piped directly from the loop main.
- 3.1.13. The main sprinkler shut-off valve, for the floor where sprinkler alterations are being made, may only be "closed" during normal business hours and must be returned to the open position for nights, holidays and weekends, unless special arrangements have been made with the Owner and the local Fire Department.
- 3.1.14. Co-ordinate changes of existing sprinkler system with all trades. Modify existing hydraulically designed sprinkler piping as required to suit new sprinkler layout and to avoid interference with ductwork and equipment. Allowances for additional work and materials required to suit site conditions and re-routing of existing and/or new services shall be included in the Tender Price.
- 3.2. TESTING OF SYSTEM
 - 3.2.1. All testing shall be executed in accordance with the latest regulations of N.F.P.A 13 and with any other regulations that the authoritative inspector demands.
 - 3.2.2. Testing shall include the flushing and cleaning of the entire system, all components operate as designed and verification of all alarm devices and indication on the building alarm panel. Provide written report on all items tested.
 - 3.2.3. Make all required arrangements, pay for, perform and witness flow and residual tests at the site before making hydraulic calculations. A copy of these results shall be submitted with the Shop Drawings.
 - 3.2.4. Arrange for proper drainage from test/drain connections including but not limited to:
 - 3.2.5. Main drain test connections
 - .1 On-floor test connections.
 - .2 System, main drain or sectional drain connections.

END OF SECTION 15501

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 - 1.2.1. Finish painting for prime painted cabinets – under Division 1.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Portable fire extinguishers shall be rated and identified in accordance with CAN/ULC-S508 “Rating and Fire Testing of Fire Extinguishers”. All ratings identified below shall be considered as a minimum.
 - 2.1.2. Portable fire extinguishers in Mechanical and Electrical Rooms shall be 6A80BC rating, 4.53 kg (10 lbs.) multi-purpose dry chemical powder type and ULC labelled.
 - 2.1.3. Portable fire extinguishers in kitchens shall be 1-A:K rating, 6 L (1.59 USgal.) wet chemical type, stainless steel, and ULC labelled.
 - 2.1.4. Portable fire extinguishers in general areas shall be minimum 3A40BC rating, 2.26 kg (5 lbs.) multi-purpose dry chemical powder type and ULC labelled (ammonium phosphate).
 - 2.1.5. Extinguishers in non-finished areas not accessible to the general public shall be mounted on wall brackets.
 - 2.1.6.
 - 2.1.7. Portable fire extinguisher cabinets in finished areas shown as Type “ “ shall be recessed type flush mounted, 1.19 mm (0.0478 in. – 18 M.S.G.) thick steel tub with black enamel interior and maximum inside dimensions of 229 mm x 610 mm x 152 mm (9 in. x 24 in. x 6 in.) deep. Front shall be adjustable with black enamel trim, 1.2 mm (0.05 in. – 18 U.S.G.) thick 304 stainless steel No. 4 vertical grain satin finish door. Glass shall be 5mm (3/16 in.) clear. Latch shall be concealed. National Fire Equipment Model CTE300-10.
 - 2.1.8.
 - 2.1.9. Portable fire extinguisher cabinets in finished areas shown as Type “ “ shall be recessed type with 6mm (1/4 in.) return frame, 0.76 mm (0.0299 in. – 22 M.S.G.) thick steel tub with enamel interior and maximum inside dimensions of 229 mm x 610 mm x 152 mm (9 in. x 24 in. x 6 in.) deep. Front shall be adjustable, 1.57 mm (0.0618 in. – 16 M.S.G.) thick steel door. Glass shall be 5mm (3/16 in.) clear. Hinge shall be full length semi-concealed piano type. Door latch shall be flush stainless steel type with no visible mounting screws. All exterior metal shall be prime coated with the exception of the door latch. National Fire Equipment Model CE-950-3.
 - 2.1.10. Extinguishers in non-finished areas accessible to the general public, such as Parking Garages, shall be surface mounted type with 1.19 mm (0.0478 in. – 18 M.S.G.) thick steel tub with enamel interior and maximum inside dimensions of 266 mm x 610 mm x 159 mm (10.5 in.

x 24 in. x 6.25 in.) deep with cylinder locked door and breakable plexi-glass. All cabinets shall be keyed alike. National Fire Equipment Model ECS-999.

3. Execution

3.1. INSTALLATION

- 3.1.1. Spacing of extinguishers shall conform to the authority having jurisdiction. Maximum spacing for ordinary hazard shall be 9 m (30 ft.) for 10 BC extinguisher and 15 m (50 ft.) for 20 BC extinguishers, but in no case shall there be less than one extinguisher in each electrical room, kitchen or mechanical room. Maximum spacing for Type A extinguishers in general offices shall be 25 m (75 ft.).

END OF SECTION 15539

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Shop Drawings:
 - .1 Submit Shop Drawings of all room ventilators with catalogued components to be supplied. Include manufacturer's data sheets for, performance criteria, ratings, and physical dimensions and finishes.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Room ventilators shall be Greenheck.
 - 2.1.2. Centrifugal fans shall be mounted in a galvanized steel, acoustically insulated housing and shall be internally isolated. Fans shall be A.M.C.A. certified for both air and sound, U.L. labelled and CSA approved.
 - 2.1.3. Arrange casing for in-line installation with access to both fan and motor through the casing.
 - 2.1.4. Inlet and discharge shall be flanged for duct connections.
 - 2.1.5. Discharge shall be complete with spring loaded backdraft damper.
 - 2.1.6. Units shall have vibration hangers where specifically shown or specified.
 - 2.1.7. Motors shall be prewired to terminal box located on the unit housing.
 - 2.1.8. Provide reverse-acting thermostat.
 - 2.1.9. All intake and discharge ductwork shall have 25 mm (1 in.) thick acoustic lining.
 - 2.1.10. Inline Fans (complete with inlet and outlet duct connections) Penn Zephyr.
"EF-2.1" Model CSP-A1050, 1093 cfm @ 0.25 in. esp
3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install room ventilators where shown.

3.1.2. All ventilators on vibration isolation hangers shall have flexible connections on both inlet and outlet.

3.1.3. Reverse acting thermostat shall be installed and wired by the Electrical Division.

END OF SECTION 15823

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. All ductwork construction, support and installation shall be in accordance with the latest ASHRAE, SMACNA, and the base building standards.
 - 1.2. SUBMITTALS
 - 1.2.1. Shop Drawings
 - .1 Submit Shop Drawings of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.
 - .2 Submit Shop Drawings of each supporting structural assembly required in the ductwork systems, designed by an engineer licensed to practice in the place of work in the appropriate discipline. Same design engineer stamps each and every Shop Drawing.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A.S.T.M. A653/A653M-98.
 - 2.1.2. Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.
 - 2.1.3. Flexible ducting:
 - .1 Flexible metal ducting shall be Flexmaster Triple-Lock Aluminum Flexible ducting T/L. ULC listing S110.
 - 2.1.4. Access Ports shall be Lawson-Taylor or other approved manufacture of 32 mm (1-1/4 in.) dia. ports. Flexible Connections:
 - 2.1.5. Dampers:
 - .1 Dampers: For right angle branch duct take-off from vertical riser; Air vector Vectrol or other approved manufacturer.
 - .2 Fire Dampers: Underwriters' Laboratories Classified to ANSI/UL 555 Standard for Fire Dampers and CAN/ULC S112 Standard Method of Fire Test of Fire Damper Assemblies or ANSI/UL 555C Standard for Ceiling Dampers as applicable.
 - .1 Fire dampers shall be curtain type, rated as 'Dynamic', and shall have the blades clear of the air stream. Fire dampers shall be Type B or Type C as required to suit system air velocity and pressure. Fire dampers in return and exhaust systems may be Type A with the blades in the air stream where permitted by the Engineer's Representative. Dampers shall be multi-sectional as required to suit

size and UL/ULC Listing requirements. Where the specified curtain fire dampers are limited by the UL/ULC Listing for maximum size, they shall be substituted with multi-blade type complete with power actuation and/or fusible link as required to satisfy the fire rating of the partition.

- .2 Fire-stop flaps or ceiling mounted fire dampers shall be as shown in the Underwriters' Laboratories Listing for the specific ceiling assembly used.
- .3 Fabricate manual duct dampers as shown on Standard Details from galvanized steel 1.26 mm thick (0.048 in – 18 GSG gauge) or heavier. Dampers for ducts up to 300 mm (12 in.) deep shall be one blade carried on a 9 mm (3/8 in.) square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300 mm (12 in.) shall be multi-blade, opposed-acting type, and shall have blades mounted in 38 mm (1-1/2 in.) steel channel frame, and interconnected for operation from one locking type hand quadrant. Dampers for right angle take-off of branch from vertical riser shall have operator extended to an accessible location. For externally insulated ducts, mount quadrant on a bracket, designed to clear the insulation. All dampers shall have indicator to show position of damper blade.

2.1.6. Hardware and Accessories:

- .1 Spin-in connections shall be specifically built for that purpose. Dampers shall be a minimum 1 gauge heavier than the ductwork in which it is installed and shall have a full length shaft pivoted at two diametrically opposed points. An indicator shall be attached to the shaft to indicate the damper position.
- .2 Hardware for balancing or splitter dampers shall be rattle-free and leak resistant. Bearing rods shall be sized to suit the damper size. Neoprene seals shall be used to minimize leaks. Hardware shall be Dyn-Air or equal.
- .3 Turning vanes shall be either double thickness or single thickness with extended leading and trailing edges as specified in ASHRAE and SMACNA Standards. Rails shall be securely set in the elbow so that they cannot loosen. Turning vanes shall be Dyn-Air or equal.

2.2. FABRICATION

- 2.2.1. Fabricate ductwork in accordance with applicable duct construction requirements of SMACNA.

3. Execution

3.1. INSTALLATION

- 3.1.1. Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
- 3.1.2. Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.
- 3.1.3. Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.

Hang all ductwork securely and in a rigid manner. Provide hangers as follows:

TABLE 1: HANGERS

DUCT DIMENSION	HANGER CONSTRUCTION
Horizontal rectangular duct	
Up to 1500 mm (60 in.) for Low Pressure Ductwork Only	Two 25 mm (1 in.) x 16 US gauge straps with two screws on side of duct one screw on bottom. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
Horizontal round duct	
Up to 450 mm (18 in.)	One 25 mm (1 in.) x 16 US gauge hanger ring supported from one 25 mm (1 in.) x 16 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
475 mm to 900 mm (19 in. to 36 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.

3.1.4. The following low pressure duct construction is based on an ASHRAE method of construction, and gives a minimum standard of construction. Alternative ASHRAE or SMACNA duct construction is acceptable, provided it meets the minimum standards as outlined by these Specifications. Submit proposed alternatives for review prior to fabrication.

3.1.5. Construct low pressure rectangular ducts for systems less than 0.5 kPa (2 in.) static pressure and under 10.2 m/s (2000 fpm) velocity as follows:

TABLE 2: LOW PRESSURE DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION AND BRACING
Up to 300 mm (12 in.)	26	Flat drive or flat 'S' no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat 'S' no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.

.1 Bracing spacing shown is maximum spacing between two bracings or between bracing and joint.

- .2 Locate bracings mid-way between joints.
Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.
- 3.1.6. Flexible hose shall be connected to sheet metal duct and diffusers using duct sealer, minimum of two screws separated by 180 degrees and metal draw bands. Duct tape is not acceptable.
- 3.1.7. Flexible ductwork may be used under the following conditions:
 - .1 Flexible ductwork shall be used where shown to allow easy location of diffusers.
 - .2 Minimum length of flexible duct used to connect diffusers and interior troffers shall be 2,400 mm (84 inches).
 - .3 Maximum length of flexible duct shall be 3,000 mm (120 inches).
 - .4 Flexible ductwork shall not pass through floors or fire walls,
 - .5 Flexible ductwork shall be a single section of duct (no joints). In the event that building construction requires connection between lengths of flexible duct use a rigid section of duct as the joint. Flexible duct shall be secure to the rigid section using ties and sealant.
 - .6 Flexible duct lengths greater than 2,400 mm (84 inches) shall be supported at the midpoint with strap hangers.
- 3.1.8. Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and airtight joint.
- 3.1.9. If changes of size of ducts are necessary because of building construction, maintain the same circular equivalent for the new size. Ratio of the longest side of the duct to the least shall not exceed 4 to 1 unless specifically authorized by the Consultant.
- 3.1.10. Select the gauge of metal and method of construction for the new size. Notify the Consultant of any change before such changes are incorporated into the work.
- 3.1.11. If changes of location of duct, are required because of building construction, review with the Consultant before the locations indicated are changed in any way.
- 3.1.12. Make changes of direction of horizontal ducts with elbows having an inside radius not less than 3/4 the width of the duct. Make change of direction from horizontal to vertical duct with elbows having an inside radius equal to the depth of the duct. Where this is not possible due to the building construction, use turning vanes.
- 3.1.13. Provide access ports at convenient locations in all main ducts and main branch take-offs with airtight covers and extension sleeves through insulation to allow air meter readings. Access ports shall be approved by the Consultant and the testing company before installation.
- 3.1.14. Provide balancing dampers for all new duct branches. Provide also balancing dampers and splitter dampers in all new ductwork as requested by the air balancing company.
- 3.1.15. Install manual duct dampers as shown on Standard Details. Ensure dampers for right angle take-off of branch from vertical riser have operator extended to an accessible location. Adjust quadrants to clear duct insulation.
- 3.1.16. Install fire dampers where shown and at all penetrations through all fire rated assemblies. Where fire dampers are shown in grilles or diffusers at ceiling level they shall be firestop flap.
- 3.1.17. Where fire dampers for ducts shown on Drawings require a change of type and/or powered actuation due to dimension limitations to satisfy the cUL Classification requirements, provide transitions as required to adjust duct dimensions while maintaining the equivalent circular duct

diameter to avoid exceeding any specific listed maximum dimension. Where transitions are not possible or dimensions cannot be adjusted to avoid powered actuation, provide power from the closest available emergency power source as required. Review all conditions with the Engineer's Representative in advance of fabrication.

- 3.1.18. Provide access panels at all fire dampers, gravity dampers, motorized dampers, coils, heaters, humidifiers, fan bearings or similar equipment requiring occasional maintenance or inspection. Panels shall be 600 mm x 450 mm (24 in. x 18 in.).
- 3.1.19. Paint visible internal surface behind each grille or register flat black.
- 3.1.20. Where duct is acoustically lined, duct dimensions shown are net, inside of lining.
- 3.1.21. Acoustic lining
- .1 Apply acoustic insulation internally to ductwork where shown. In addition, internally line all low or medium pressure supply air ductwork in mechanical rooms, fan rooms, or equipment rooms.
 - .2 For acoustic lining or silencers downstream of VAV boxes refer to Section 15861 – VARIABLE VOLUME BOXES.
 - .3 Install using both pins and adhesive. Pins shall be maximum 450 mm (18 in.) centres and shall be tack welded to the duct or plenum. Seal all edges of acoustic insulation to prevent air erosion with sheet metal nosing that overlaps the insulation by 19 mm (3/4 in.) minimum.
- 3.1.22. Spin-in connections shall only be used downstream of variable volume boxes.
- 3.1.23. Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.
- 3.1.24. All open ends of ductwork that do not have a diffuser, grille or register shall have a protective screen mounted in a suitable frame to connect the screen securely to the duct, wall and floor as applicable. Where a duct terminates at a supply, return or exhaust air opening provided by other sections and located less than 2000mm (79 in.) Above the finished floor, the screen shall be installed and painted matte black and shall not be capable of passage of anything larger than a 15mm (1/2 in.) Sphere through the openings.
- 3.1.25. Supply air ductwork to variable volume boxes shall be rigid duct of size shown in schedules. If the length exceeds 3000 mm (10 ft.) or if there are 2-45 deg. elbows or 1-90 deg. elbow or more increase in supply air ductwork to the variable volume box one size. If the length exceeds 6000 mm (20 ft.) increase the duct by two sizes. Under no conditions shall be supply ductwork exceed 9000 mm (30 ft.) or have more than 3-90 deg. elbows or the equivalent.

END OF SECTION 15840

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 - 1.2.1. Actuator for damper and controller furnished under Section 15900 – BUILDING AUTOMATION SYSTEM (BAS).
 - 1.3. SUBMITTALS
 - 1.3.1. Shop Drawings: Submit Shop Drawings of all components in accordance with Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.3.2. Manufacturer's Data: Submit manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63. Where a second sound attenuator is required in the system or where attenuators with outlets are used in conjunction with rated outlets and not as straight attenuators without outlets, submit certified data for review.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. The mechanical variable volume boxes shall be E.H. Price, Titus, Nailor or Environmental Technologies as shown and specified below. Air Vector, Mitco and Krueger boxes maybe listed on Supplementary Bid Form as substitutes only if all requirements shown and specified are met.
 - 2.1.2. Boxes shall be low pressure terminal boxes having unit casings fabricated of galvanized steel of sufficient thickness to prevent drumming or rattling, and lined with 25 mm (1 in.) thick thermal and sound attenuating insulation. The units shall be end outlet and shall be complete with pneumatic operator and a constant volume regulator requiring no external power source. The controller shall always modulate through its full reset span regardless of maximum and minimum air flow settings. Leakage through the unit casing shall be less than 0.3% of the design volume.
 - 2.1.3. Design volumes shall be factory preset and calibrated and both maximum and minimum volumes shall be independently adjustable in the field, by using a cfm scale and without changing components. The box volumes are shown on Drawings. For all boxes, the minimum volume shall be set at the minimum volume recommended by the manufacturer. Maximum volume control shall be maintained within plus 5% of volume shown for box, with inlet pressures of 0.05 to 1.5 kPa (0.2 in. to 6 in.) of water.
 - 2.1.4. Acoustically line ductwork downstream from boxes as shown. Lengths of 25 mm (1 in.) thick acoustic lining, shall be as designed in following Schedules:

BOX VOLUME	LENGTH
755.5 to 1180 L/s (1601 to 2500 cfm)	6100 mm (20 ft.)
283.5 to 755 L/s (601 to 1600 cfm)	4600 mm (15 ft.)
95 to 283 L/s (201 to 600 cfm)	3000 mm (10 ft.)
Under 94.5 L/s (200 cfm)	1500 mm (5 ft.)

- 2.1.5. With the scheduled lengths of lined duct and a room attenuation of 8 db, the sound power level with reference to 10 to the -12 power watts shall be such that the sound pressure level in the room receiving air and in room in which the box is located, shall not exceed noise criterion 32 at an inlet static pressure 0.37 kPa (1.5 in. wg.) with noise generated by diffusers excluded. Provide manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63.
- 2.1.6. When the scheduled lengths of lined duct cannot be obtained and/or where specifically shown, utilize straight attenuators.
- 2.1.7. With these attenuators and a room attenuation of 8 db, the sound power level with reference to 10 to the -12 power watts shall be such that the sound pressure level in the room receiving air and in room in which the box is located, shall not exceed noise criterion 32 at an inlet static pressure 0.37 kPa (1.5 in.wg.) with noise generated by diffusers excluded. Provide manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63.
- 2.1.8. Where one attenuator fails to provide the sound attenuation required, utilize additional attenuators or lengths of duct lining. Where attenuators with outlets are used they shall be rated with the outlets and not as straight attenuators without outlets.
- 2.1.9. Where outlets are provided they shall be complete with manual dampers in each outlet.
- 2.1.10. The box radiated noise level shall meet the criteria for specific room noise levels as specified under Section 15200 – VIBRATION AND NOISE CONTROL.
- 2.1.11. Pressure drop for L/s (cfm) ranges shown for each box size shall be 0.07 kPa (0.3 in.wg.) maximum. Boxes shall be capable of modulating down to the minimum volume shown and shall shut-off tight where zero L/s (zero cfm) is shown.
- 2.1.12. Where a manufacturer requires main control air to the box, it is the responsibility of this section to ensure that main air is provided by Section 15900 – BUILDING AUTOMATION SYSTEM (BAS). Failure to do this shall be at the expense of this section and shall be corrected at no cost to the Owner.
- 2.1.13. All interior and perimeter boxes shall be normally open.
- 2.1.14. Dump boxes shall be similar to variable air volume boxes, but shall maintain room conditions by bypassing supply air to the return air.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install VAV boxes in accordance with reviewed Shop Drawings and to manufacturer's instructions.

- 3.1.2. Disconnect and remove existing VAV with all connecting ductwork and related controls where shown; relocate and reconnect as indicated on the drawings.
- 3.1.3. Salvage existing VAV boxes that are not being reused, and hand over boxes and controls to the Landlord. Cap and seal all unused duct openings with sheet metal, screws, and duct sealer where components are being reused, store in a secured location to avoid damage.
- 3.1.4. Air velocity sensor, actuator for damper, controller and interconnecting tubing and cable are installed by terminal box manufacturer at its manufacturing facilities; the costs for installation labour are paid for by this Section. Make control devices readily accessible from the access panel in the suspended ceiling.
- 3.1.5. Where a VAV box does not meet specified sound ratings, field enclose with (0.80 mm thick (1 lb.) lead sheeting over a 25 mm thick (1 in.) glass fibre blanket wrap, as part of the work.

END OF SECTION 15861

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 - 1.2.1. Continuous air slot in ceiling – under Division 9 – Finishes.
 - 1.2.2. Door grilles – under Architectural Division – Grilles.
 - 1.3. SUBMITTALS
 - 1.3.1. Shop Drawings: Submit detailed Shop Drawings of all components furnished under this Section. Manufacturer to indicate ceiling installation type for each type of diffuser specified.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Diffusers, registers and grilles shall be Price, Nailor, Krueger, Titus or Carnes equal to the units specified.
 - 2.1.2. Select all diffusers to provide uniform air coverage without overlap. Air velocity up to a height of 1800 mm (6 ft.) above the floor shall be 0.127 to 0.254 m/s (25 to 50 fpm).
 - 2.1.3. Noise generated by diffusers shall be such that room sound pressure level does not exceed noise criteria 32 with 8 db room attenuation, the sound power level reference to 10 to –12 power watts.
 - 2.1.4. All volume and air pattern devices shall be fully adjustable from the face of the diffuser, register or grille.
 - 2.1.5. In T-bar ceilings, manufacturer shall coordinate diffuser compatibility with t-bar ceiling specified by the architectural division. Colour shall match colour of ceiling tile in lay-in ceilings. Diffusers to suit ceiling grid as required imperial or metric.
 - 2.1.6. Diffusers shall meet test requirements of A.S.H.R.A.E. Standard 36B-63, including air pattern and noise levels for air quantities from 10% to 110% of the required maximum air flow. Sound power tests shall be measured in accordance with ASHRAE Standards 36B-63 and NC ratings shall be determined using an 8 db room attenuation factor
 - 2.1.7. SQUARE SUPPLY DIFFUSERS
 - 2.1.8. LINEAR SUPPLY AND RETURN DIFFUSERS
 - 2.1.9. All diffusers shown as type “T1” shall be T-bar plug-in, 1 in. slot width, 1 slot diffuser modified with square ends to limit side spread, and of lengths shown. Diffuser shall be installed with

manufacturer plenum to match the length of the diffuser shown. Provide diffuser with mounting clips to suit in continuous T-bar openings. Pattern controllers shall be split mid length to allow each half of diffuser shall be set for different throw patterns. Throw patterns shall be fully adjustable from vertical to horizontal and variations in between. Provide blank-off panels between diffusers. Pattern controllers and blank-off panels shall be finished matte black. Plenum shall be fabricated from coated steel. Refer to Architectural Details for installation of continuous supply air slot. Duct connection to diffuser shall be of sufficient height to allow for 175 mm (7 in.) clearance from ceiling to underside of duct. EH-Price TBD3 series, Nailor 5800, Krueger PTBA, Carnes DASC.

.1 All diffusers shown as type "T2" shall be as above with 2 slots.

2.1.10. RETURN, EXHAUST AND TRANSFER GRILLES

2.1.11. Return grilles shown as type "E" shall be size as shown and shall be egg crate type with aluminum construction. Egg crate shall be 12 mm (1/2 in.) deep, formed of 12 mm (1/2 in.) wide aluminum strips on 12 mm (1/2 in.) centres. Strips shall be approximately 0.64 mm (0.025 in.) thick. Grilles shall be enclosed in a channel frame for inverted T-bar mounting or with a flanged frame for plaster or gypsum ceiling mounting. Grilles shall lay on inverted T-bar ceiling suspension system. Colour shall match adjacent ceiling tiles. E.H. Price Series 80, Nailor 5100 Series, Krueger EGC5 Series, Carnes RAPAHA.

2.1.12. Door transfer grilles unless otherwise specified shall have finely spaced blades for an attractive sight proof appearance and are designed for applications in doors or partitions with Sections as thin as 35 mm (1-3/8") with flat border and countersunk holes. E.H. Price type ATGH.

3. Execution

3.1. INSTALLATION

3.1.1. Refer to the architectural drawings for actual locations of diffusers, grilles and registers and install to suit these drawings. The mechanical drawings show intent and number of diffusers, grilles and registers required.

3.1.2. Relocate and reuse existing diffusers and grilles as indicated on plans.

3.1.3. Provide transfer grilles in all finished spaces where air is transferred through a ceiling or partition. Provide transfer grille on both sides of the finished areas.

3.1.4. For special mounting of diffusers, grilles and registers refer to Architectural Drawings.

3.1.5. Where rigid duct is connected to the diffuser, grille or register all devices used for flow pattern adjustment, flow balancing and flow equalizing shall be accessible from the face of the diffuser.

3.1.6. Install mounting frame tied into plaster and gypsum board ceilings to allow lay in type diffusers to rest on the frame.

3.1.7. Diffusers for installation in lay-in ceiling shall lay on inverted T-bars.

3.1.8. Contractor shall be responsible for mounting concealed flange linear diffusers in heated environment and following manufacturers' instructions.

3.1.9. Contractor shall caulk around edges of linear diffusers in installations with imperfect walls.

END OF SECTION 15870

1. General
 - 1.1.. WORK INCLUDED
 - 1.1.1. Provide all labour, materials, products, equipment and services to supply, install, test and commission building automation system (BAS) with direct digital control (DDC) for building mechanical and electrical systems and interface with other microprocessor based building subsystems as indicated on drawings and described herein.
 - 1.2.. EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS
 - 1.2.1. Automatic control valves except otherwise noted, temperature sensor wells, motorized dampers except otherwise noted. Verify damper sizes and connection type with sheet metal contractor prior to ordering.
 - 1.3.. SUBMITTALS
 - 1.3.1. Before start of construction, submit completely engineered and coordinated shop drawing package with all control diagrams, points lists, valve, damper, room and room temperature sensors schedules and all equipment data sheets.
2. Products
 - 2.1.. CONTROL DEVICES
 - 2.1.1. Digital Thermostat: 7-day programmable digital type suited for the application, user selectable engineering units (F or C) and set point adjustment, support automatic daylight savings time switchover and automatic heat/cool changeover when applicable.
 - 2.1.2. Temperature Sensors: resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.
3. Execution
 - 3.1.. GENERAL WORKMANSHIP
 - 3.1.1. Install all controllers, cabinets, control devices and power supplies in readily accessible locations providing adequate ambient conditions for its specified application and to the Canadian electrical code. Install products to manufacturer's installation instructions. Install parallel to building walls and floors unless indicated or specified or required otherwise by manufacturer's installation instructions. Mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
 - 3.2.. EXISTING PRODUCTS

- 3.2.1. Apply reused existing products to the same requirements for new products. During construction check and verify reused existing products are operational. For existing product that is not operational submit a proposal to replace existing product for approval by the consultant.

 - 3.3.. WIRING AND CONDUIT
 - 3.3.1. Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.), but must not pass over lighting fixtures. Wiring in equipment room, between floors, or between concrete walls shall be installed in conduit. Exposed wiring will not be accepted. Conduit shall be installed at right angles or parallel to the building walls.

 - 3.4.. POWER WIRING
 - 3.4.1. Power for building automation system (BAS) shall be provided under electrical division at 120 VAC 60 Hz single phase and shall terminate in junction boxes installed where shown on electrical and mechanical drawings. Wiring and conduit from these boxes to control devices being electrically powered to be provided by building automation system (BAS) contractor.

 - 3.5.. COMMUNICATION WIRING
 - 3.5.1. Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.

 - 3.6.. IDENTIFICATION
 - 3.6.1. All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable. Label wires, control devices, controllers.

 - 3.7.. TESTING AND COMMISSIONING
 - 3.7.1. Test and commission the BAS prior to the Demonstration. Prepare test forms which shall identify each test. The forms shall be sub-divided into points, controllers, programs, loops, networks and graphics.

 - 3.8.. DEMONSTRATION
 - 3.8.1. When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the BAS are operating.

 - 3.9.. INSTRUCTION AND TRAINING
 - 3.9.1. Provide one day of instruction that shall cover the operation and maintenance of the BAS.
- END OF SECTION 15900

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Conform to Section 15900 – BUILDING AUTOMATION SYSTEM (BAS)
 - 1.2. DESCRIPTION
 - 1.2.1. Provide pneumatic controls as indicated on the drawings and as specified.
 - 1.3. CODES AND STANDARDS
 - 1.3.1. Comply with rules and regulations of codes and ordinances of local, provincial, and federal authorities; such codes and ordinances, when more restrictive, take precedence over the Contract Documents.
 - 1.3.2. Provide products listed and classified by the testing firm acceptable to the authority having jurisdiction as suitable for the purpose indicated and specified.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Existing Products: To Part 3: Execution, Existing Pneumatic Products.
 - 2.1.2. Input/Output Interface:
 - .1 Pneumatic Analog Outputs:
 - .1 Signal: 0 to 138 kPa (0 to 20 psig).
 - .2 Accuracy Rating: +/- 1% of scale length.
 - 2.2. CONTROL DEVICES
 - 2.2.1. Actuators for Dampers, Pneumatic:
 - .1 Type: Piston-rolling diaphragm.
 - .2 Spring Range: Suitable for the application.
 - .3 Mounting: Outside the air stream with corrosion resistant hardware.
 - .4 Pilot Positioners: For signal amplification, sequencing when spring ranges overlap, and for mixed air applications.
 - .5 Position Indication: Mark blade position on damper drive shaft or jackshaft.
 - .6 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.

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- 2.2.2. Actuators for Control Valves, Pneumatic:
- .1 Type: Piston-rolling diaphragm.
 - .2 Spring Range: Suitable for the application.
 - .3 Pilot Positioners: For signal amplification, sequencing when spring ranges overlap, and for valves greater than 50 mm (2 in.).
 - .4 Position Indication: Indicate valve open and closed positions.
 - .5 Close-off Pressure:
 - .1 Water:
 - .1 Two-way: 150% of total system head.
 - .2 Three-way: 300% of the pressure differential between ports A and B at design flow, or 100% of total system head.
 - .2 Steam: 150% of inlet pressure.
- 2.2.3. Pilot Positioners:
- .1 Type: Force balance relay.
 - .2 Mounting: Factory or field mounted with corrosion resistant hardware.
 - .3 Position Feedback: Linkage Type.
 - .4 Maximum Working Pressure, Pilot: 207 kPa (30 psig).
 - .5 Maximum Working Pressure, Supply Air: 413 kPa (60 psig).
 - .6 Response: 0.7 kPa (0.10 psi) input change.
 - .7 Materials: Body: Zinc. Cover: Steel.
- 2.2.4. Pneumatic Thermostats:
- .1 Wall Mount:
 - .1 Two-pipe with main air pressure and branch control air pressure; single set point with an output pressure range of 21 kPa to 90 kPa (3 to 13 psig).
 - .2 Stops for temperature settings; without thermometers; set-point adjustment.
 - .3 Dimensions: Maximum 250 mm wide x 75 mm high x 38 mm deep (10 in. wide x 3 in. high x 1-1/2 in. deep).
 - .4 Covers: Blank, concealed, with locks. Provide samples of covers to Part 1: Submittals, Samples.
- 2.2.5. Pressure-Electric Switches:
- .1 Type: Diaphragm operated.
 - .2 Electrical Contacts: Single-pole double-throw (SPDT) snap-acting; rated for 5 A resistive, 3 FLA at 120 VAC.
- 2.2.6. Electric-Pneumatic Valves:
- .1 Internal Materials: Bronze for operating parts.
- 2.2.7. Pneumatic Gauges:
- .1 Dimensions: 38 mm (1-1/2 in.) diameter; scaled 0 to 172 kPa (0 to 25 psig).
 - .2 Maximum Working Pressure: 241 kPa (35 psig).

2.3. CONTROL AIR TUBING

- 2.3.1. Type M hard drawn copper tubing or soft annealed copper tubing with solder fittings and joints.
- 2.3.2. Non Life Safety Systems: FR polyethylene tubing with compression joint fittings or barbed fittings, as applicable, in ceiling plenums to local authorities having jurisdiction.

3. Execution

3.1. GENERAL WORKMANSHIP

- 3.1.1. Install products to manufacturer's installation instructions.
- 3.1.2. Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.

3.2. COORDINATION

- 3.2.1. Submittals: To Part 1: General, Submittals.

3.3. EXISTING PNEUMATIC PRODUCTS

- 3.3.1. Apply reused existing pneumatic products to the same requirements for new products.
- 3.3.2. Performance: During construction check and verify reused existing pneumatic products are operational. For existing product that is not operational submit a proposal to replace existing product for approval by the Engineer's Representative.
- 3.3.3. Existing Control Air Tubing: Reuse
- 3.3.4. Existing Pneumatic Cabinets: Reuse.
- 3.3.5. Existing Pneumatic Sensor Wells: Reuse.
- 3.3.6. Existing Pneumatic Thermostats: Salvage and reuse.
- 3.3.7. Existing Dampers, Pneumatic Damper Actuators and Linkages: Salvage and reuse.
- 3.3.8. Existing Control Valves and Pneumatic Valve Actuators: Salvage and reuse.
- 3.3.9. Existing Control Compressed Air System: Salvage and reuse.

3.4. CONTROL DEVICES

- 3.4.1. Provide or furnish control devices as indicated on the drawings and to the requirements of this Section and to execute sequence of operation under Section 15951 – SEQUENCE OF OPERATION FOR BAS.
- 3.4.2. Actuators for Control Valves, Pneumatic:
 - .1 Factory install or field install actuator to valve body.

3.4.3. Pneumatic Thermostats:

- .1 Furnish sensing wells for installation under Section 23 21 13.23 – PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
- .2 Samples: Provide for wall mount type to Section 15900 - BUILDING AUTOMATION SYSTEM (BAS), Part 1: Submittals, Samples.
- .3 Wall Mount Type:
 - .1 Cover Colour: White.
 - .2 Install to furred-in columns and permanent walls. Installation to mobile and temporary partitions is not accepted.
 - .3 Installation to exposed architectural concrete columns and walls is not accepted, unless otherwise indicated or specified. For installation to concrete, set conduit in place before pouring of concrete.
- .4 Single Point Type, Duct:
 - .1 Provide sufficient contact with process fluid to measure average conditions.
 - .2 Install Duro Dyne Instrument Test Port Model IP-4, or equivalent, to duct adjacent to control device; apply pipe sealing compound to plug thread.
- .5 Single Point Type, Pipe: Provide sufficient contact with process fluid to measure average conditions.

3.5. CONTROL AIR TUBING

- 3.5.1. Copper tubing shall be used with exceptions noted hereafter.
- 3.5.2. Plastic fire retardant tubing may be used in Mechanical Rooms when installed in aluminum tray or in EMT conduit. Identify tubing at both ends and at junction boxes. Where tubing is used within panels, install in plastic tray and identify at both ends. Obtain approval for plastic fire retardant tubing from the local authorities.
- 3.5.3. Run pneumatic tubing to follow horizontal and vertical lines of the building to suit the area and equipment, and support and install in a neat, orderly manner throughout.
- 3.5.4. Support pneumatic tubing independent of ductwork and conduit, except on tenant floors where tubing may be secured to ductwork hangers at the ceiling level only. Secure plastic tubing at maximum 1500 mm (5 ft.) OC, and at maximum 2400 mm (8 ft.) OC for copper tubing.
- 3.5.5. Plastic tubing shall have barbed compression joint fittings.
- 3.5.6. Copper tubing shall have soldered copper fittings. Copper to plastic tubing connections shall be compression joint fittings.
- 3.5.7. Test the pneumatic main air tubing system to a pressure of 1.5 times the normal pressure for a period of 24 hours. Document results and sign the test form. Pressure drop during the test period shall not exceed 20 kPa (3 psi). If test fails, correct the problem and retest the system.
- 3.5.8. Provide main air pressure gauge at each control panel, at the entry to each mechanical room, on each floor at the take-off from the riser, before and after each PRV.

3.6. IDENTIFICATION

- 3.6.1. All tubing shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.
- 3.6.2. All tubing passing through a junction box shall be tagged with the device identity or its termination point.
- 3.6.3. The junction boxes shall be tagged "BAS" with a sequential number suffix.
- 3.6.4. Label tubing, control devices, controllers.

- 3.7. TESTING AND COMMISSIONING
- 3.7.1. Test and commission Pneumatic Controls prior to the Demonstration and Acceptance Test.
- 3.7.2. Prepare test forms which shall identify each test.
- 3.7.3. Device tests shall identify and confirm successful completion of the following:
 - .1 Device installation.
 - .2 Device identification.
 - .3 Device calibration.
 - .4 Device operation.
 - .5 Tubing to device, connection details and tube type.
 - .6 Validation of the device signal at the controller.
- 3.7.4. Tests shall identify and confirm successful completion of the following:
 - .1 Pressure test of tubing.
 - .2 Compressed Air Supply tests.
- 3.7.5. The system shall not be considered complete until it is tested, commissioned, demonstrated, accepted, and with training provided to Section 15900 – BUILDING AUTOMATION SYSTEM (BAS).

END OF SECTION 15920