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MECHANICAL SPECIFICATION

FOR

CITY OF BRAMPTON 5 RAY LAWSON BOULEVARD, BRAMPTON, ON REPLACEMENT OF ROOFTOP UNITS – POA COURTHOUSE

THIS SPECIFICATION SHALL BE READ IN CONJUNCTION WITH DRAWINGS:

REFER TO DRAWING LIST ON DRAWING M.000

OUR PROJECT NUMBER:

21344.002.M.001

DATE:

2023-09-28

ISSUED FOR:

TENDER

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20 05 00.00 General Instructions for Mechanical Sections

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to the requirements of scope of work description in mechanical drawings, 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 Subcontractors nor between the Contractor and their Subcontractors. 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.
- 1.2. 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. Consider any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, 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 Division 20, 22, and 23 Sections referred herein as Mechanical.

1.4. DEFINITIONS

- 1.4.1. Where used on the Drawings or in the Specifications, the following words are given the meanings below.
 - .1 Provide: means supply, install, connect and test.
 - .2 Demolish: detach existing items and legally dispose of them off site.
 - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
 - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to Owner), or removed and reinstalled.
 - .5 Remove and Salvage: detach existing items and turn over to Owner.

1.5. REGULATIONS

- 1.5.1. Perform Work in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- 1.5.2. Comply with regulations respecting plumbing made under the following legislation except as modified by rules, regulations and by-laws of authorities having jurisdiction:
 - .1 Ontario Water Resources Act.
 - .2 Ontario Building Code Part 7.
- 1.5.3. For natural gas systems, follow the requirements of:
 - .1 Regulations made under the Technical Standards and Safety Act
 - .2 CAN/CSA B149.1 Natural Gas and Propane Installation Code.
 - .4 Gas Protection Act and Gas Protection Regulations.
- 1.5.4. Provide materials and assemblies with flame-spread ratings and smoke developed classifications in conformance with CAN/ULC-S102 "Test for Surface Burning Characteristics of Building Materials and Assemblies." Compliance with ASTM E84 "Surface Burning Characteristics of Building Materials" in lieu of CAN/ULC-S102 is not acceptable.
- 1.5.5. These Specifications are supplementary to the requirements above.
- 1.5.6. Drawings and Specifications should not conflict with the above regulations but where there are apparent discrepancies, notify the Engineer's Representative.
- 1.5.7. Where equipment utilizing refrigerants is provided, comply with regulatory refrigerant phase out requirements and dates applicable in the jurisdiction where the Project is taking place. Where equipment not meeting refrigerant phase out requirements or dates is supplied to site, provide revised unit(s) operating on a new refrigerant at no additional cost to the Owner; cover all costs of any electrical, structural, mechanical, architectural, etc. changes required to accommodate the new refrigerant.

1.6. PERMITS, FEES AND INSPECTIONS

- 1.6.1. Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the Work of this Division.
- 1.6.2. Contractor required to submit their hot work permit to the owner for review. Alternatively, the facility may provide the permit template upon contractor's request. It is mandatory for contractor to complete the permit on daily basis throughout the construction period.

1.7. EXAMINATION OF SITE

1.7.1. Before submitting Bids, 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.

1.8. DRAWINGS, CHANGES AND INSTALLATION

- 1.8.1. The Drawings show the general character and scope of the Work and not the exact details of the installation. Install all equipment and systems complete with all accessories required for a complete and operational installation.
- 1.8.2. 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 Engineer's Representative to make reasonable changes required to accommodate conditions arising during the progress of the Work, at no additional cost.

- 1.8.3. 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.
- 1.8.4. Install equipment in accordance with the manufacturer's written installation requirements. In the event of conflicts between the Drawings or Specifications and the manufacturer's written installation requirements, notify the Engineer's Representative for resolution.
- 1.8.5. 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 are applicable to every occurrence.
- 1.8.6. Conceal all piping and ductwork in finished areas in ceiling spaces and shafts or furred into walls. Do not install exposed piping or ductwork in such areas unless specifically reviewed and accepted by the Engineer's Representative. Do not install piping in outside walls.
- 1.8.7. Do not install vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment, closer to the edge of the roof than a distance equal to the height of the pipe, hood or equipment, unless specifically reviewed and accepted by the Engineer's Representative.
- 1.8.8. The location and size of existing services shown on the Drawings are based on the best available information. Site verify the actual location of existing services before commencing Work. Pay particular attention to underground services.
- 1.8.9. Make changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, at no additional cost.
- 1.8.10. Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.
- 1.8.11. Allow adequate space and provisions for the removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.8.12. Where equipment is shown to be 'roughed-in only,' obtain accurate information from the Engineer's Representative before proceeding with the Work.
- 1.8.13. 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. Submit any problems that cannot be solved in agreement with the other Trades affected, for resolution. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, make necessary changes in such prefabricated items at no additional cost.
- 1.8.14. 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 Drawings and to Supplemental Instructions in all regards. Revise any Work not installed in the correct location (at the sole discretion of the Engineer's Representative) at no additional cost. Mark-out fully co-ordinated Work with all other trades, in sufficient time for review by Engineer's Representative prior to rough-in. Precisely locate all mechanical and sprinkler services.
- 1.8.15. Prepare dimensioned layouts of each room prior to rough-in for review by the Architectural Consultant. Do not proceed with any Work until the Engineer's Representative has reviewed the layout.

1.9. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

- 1.9.1. Submit installation, interference and setting drawings dimensioned and to scale, for review by the Engineer's Representative, as may be required or requested by the Engineer's Representative to make clear the Work intended or to show its relation to adjacent Work or to the Work of other trades. When an alternative piece of equipment is substituted for equipment shown, prepare drawings of the area involved. Submit drawings in pdf format as well as in the format the Tender Drawings are prepared.
- 1.9.2. Prepare installation working drawings to 1:50 scale (1/4 in. equal to 1 ft.) for mechanical rooms showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, etc.
- 1.9.3. Prepare interference drawings for shafts, ceiling spaces, typical floors and wherever there is possible conflict with the positioning of mechanical equipment, piping or ductwork and architectural or structural features or the Work of other trades.
- 1.9.4. The design of the structural framing of the mechanical rooms and pipe spaces and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit drawings for review by the Engineer's Representative showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure.
- 1.9.5. Prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for piping, ductwork and equipment. Bear the cost of all extra work necessary due to failure to provide information in time (i.e. before the concrete is poured).
- 1.9.6. Do not proceed with Work in areas involved until after final review of such drawings has been obtained.

1.10. MATERIALS

- 1.10.1. Make and quality of materials used in the construction of this Work are subject to the approval of the Engineer's Representative.
- 1.10.2. Supply only new materials and equipment, free from defects and as specified by the manufacturer's name and catalogue reference.
- 1.10.3. Where a manufacturer's equipment has been specified by name and/or model number, ensure that the performance and quality of equipment provided by an acceptable manufacturer, meets the specified equipment performance, is inclusive of all standard and specified optional features, and can be installed in the planned location with access and maintenance clearances in accordance with the manufacturer's written installation recommendations. Provide all required piping, duct and electrical connections at no additional cost.

1.11. CO-OPERATION WITH ENGINEER'S REPRESENTATIVE

1.11.1. To assist in the successful execution of the Project, the Contractor will receive an initial job report that summarizes the expectations of the Engineer's Representative and the Contractor. This job report covers topics such as progress billings, shop drawing requirements, Change Order pricing, the commissioning process, installation drawings, the Specifications, as-built drawings and operations and maintenance manuals, along with a number of other items. This job report is intended to reiterate key items from the Contract Documents and is not intended to impose new requirements.

- 1.11.2. At the appropriate time during construction, submit the applicable documentation listed below. The Engineer's Representative will review the information and identify when the information is complete. The Engineer's Representative's general review letter (required for building occupancy) will only be issued when the information requested below is submitted by the Contractor and deemed to be complete by the Engineer's Representative.
- 1.11.3. For mechanical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:
 - .1 Fire alarm verification certificate
 - .2 Contractor's letter confirming ventilation supply air and return air available for each room
 - .3 Contractor's letter verifying fire stops and smoke seals installed in accordance with Mechanical Specification
 - .4 Contractor's letter verifying fire damper installations are in accordance with their listings and the Mechanical Specification, and fire damper test confirmation letter
 - .5 Start up report(s) for heating systems etc.
 - .6 Contractor's letter confirming that emergency power generation ventilation system is installed, operational and commissioned
 - .7 Start up report(s) for ventilation systems, air handling unit(s, etc.
 - .8 Start up report(s) for cooling systems including air handling unit(s) etc.
 - .9 Air balancing report
 - .10 Hydronic (Piping) balancing report
 - .11 Where the Owner has hired a third party commissioning agent, all documentation and completion of the commissioning process submitted up to the initial BAS commissioning stage where the system is ready for season performance testing, where relevant.
- 1.11.4. For mechanical systems financial close, provide the following additional documents to the Engineer's office for review:
 - .1 Copies of as-built drawings
 - .2 Operating and maintenance manual
 - .3 Warranty letter

1.12. SUBSTANTIAL PERFORMANCE

- 1.12.1. The Owner will not deem the Project "ready for use" as defined in the provincial or territorial lien legislation until the following minimum items are complete:
 - .1 Everything required in the clauses above for occupancy.
 - .2 All mechanical items commissioned and accepted by Engineer's Representative as noted in Specification Section 20 08 00.00 COMMISSIONING.
 - .3 Submission of final, reviewed Operating and Maintenance Manuals including final reviewed Shop Drawings turned over to the Engineer's Representative and Owner as outlined in Section 20 08 03.00 OPERATING AND MAINTENANCE INSTRUCTIONS.
 - .4 Submission of final, reviewed as-built documentation to the Engineer's Representative and Owner, as outlined in Specification Section 20 05 02.00 AS-BUILT DRAWINGS. Note that this includes all final balancing reports.

1.13. CO-OPERATION WITH OTHER DIVISIONS

- 1.13.1. Pay particular attention to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.13.2. Maintain at least 150 mm (6 in.) separation between pipes transporting hot fluids and pipes carrying cold fluids, unless approval from the Engineer's Representative is obtained.
- 1.13.3. Do not allow Electrical conduits to touch or be supported from piping or ductwork.
- 1.13.4. Install 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, relocate the materials to their proper space allocation in such a manner to complete the Work using space allocated to the various Sections and Divisions. Relocate materials and Work involved at no additional cost.
- 1.13.5. 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.
- 1.13.6. 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. Report any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division to the Engineer's Representative and supply equipment to suit the appropriate power requirements. Bear all costs associated with failure to perform this coordination prior to ordering of the motors or equipment.

1.14. TEMPORARY USE OF EQUIPMENT

- 1.14.1. Where systems, or a part thereof, are operated during construction, maintain the system and equipment in proper operating condition.
- 1.14.2. Prior to application for Substantial Performance of the Work as certified by the Engineer's Representative, return the systems and/or equipment to new condition by replacing all consumables such as air or water filters, belts in belt driven equipment, etc. with new components. Clean the air side of all coils in the air handling systems, lubricate all bearings according to manufacturer's written factory standards and adjust the thermostatic control system according to Specifications. Clean all duct systems to NADCA Standards.

1.15. EXISTING SERVICES AND EQUIPMENT

- 1.15.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the Owner's Representative so as to avoid any interruption of such services during normal working hours. If necessary, make changes and connections to existing services outside of normal working hours, without additional cost.
- 1.15.2. Whenever existing services or equipment are to be removed, remove all associated piping and ducts back to the main, nearest pipe or duct and securely cap or plug open ends in an approved manner. If necessary to facilitate installation of new Work, remove existing services and equipment and then replace without additional cost.
- 1.15.3. Whenever it becomes necessary to relocate existing piping, ducts or equipment to make possible installation of the Work under this Contract, make such relocation without additional cost.
- 1.15.4. Where connections are made to existing services, replace and make good existing insulation.

1.16. INTERRUPTION OF SERVICES

- 1.16.1. Schedule interruptions of the mechanical services to any part of the building at a time agreeable to the Owner's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- 1.16.2. Obtain approval from the Engineer's Representative for testing and operation of major equipment to avoid excessive utility charges. Such testing is to be generally carried out after normal working hours or on weekends.
- 1.16.3. Perform all such overtime Work at no additional cost. Since the courthouse is closed on the weekend only, it is mandatory to perform works during weekend.

1.17. STATEMENT OF PRICES

- 1.17.1. For the purpose of progress applications, submit a summary statement of 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 must equal the total price of the Work covered under Divisions 20, 22 and 23.
- 1.17.2. Submit the summary of Work for this Contract to the Engineer's Representative for review and approval. Provide sufficient detail in the summary to enable the Engineer's Representative to evaluate the progress of Work and identify all major equipment, components and sub trades.

1.18. METRIC CONVERSIONS

- 1.18.1. Take particular care with imperial versus SI metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- 1.18.2. Conform to CAN/CSA-Z234.1 "Metric Practice Guide."

1.19. ALTERNATIVE AND IDENTIFIED PRICES

1.19.1. If alternative and unit prices have been requested, include on the Bid Form. Prices not on the Bid Form at time of submission will not be accepted. Refer to the Specifications and the Drawings for details.

1.20. DEMOLITION

- 1.20.1. The 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.
- 1.20.2. 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 will be paid for from the contingency. Co-ordinate with the Engineer's Representative to shut-down the system. Install caps on all services. Add caps to all valves at the termination point of existing services.
- 1.20.3. Where valves are removed, remove valve tags, revise existing charts and hand tags over to Owner.
- 1.21. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP
- 1.21.1. 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.

- 1.21.2. 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.
- 1.21.3. Refer to the security and protection requirements in the General Conditions and conform to all requirements. In particular:
 - .1 No open flames without prior written approval of the Owner.
 - .2 No smoking.
 - .3 Keep the site clean at all times.

1.22. HOUSEKEEPING PADS, CURBS AND SUPPORT PIERS

- 1.22.1. Provide dimensioned drawings for final sizes and locations for housekeeping pads, support piers, and curbs around all floor penetrations for pipes and ducts. Submit for review by Division 3 and the Engineer's Representative. Extend edge of equipment housekeeping pad 100 mm (4 in.) beyond equipment frame and hold down bolts. Refer to the Drawings and Details for additional information.
 - .1 Mechanical Division shall furnish curbs and housekeeping pads.
 - .2 Mechanical Division shall furnish and install equipment support piers.
- 1.22.2. Provide housekeeping pad and curb heights as follows:
 - .1 Air handling equipment with cooling coils: 150 mm (6 in.).
 - .2 Air handling equipment with heat wheels: 200 mm (8 in.).
 - .3 All other equipment: 100 mm (4 in.).
 - .4 Curbs around floor penetrations: 50 mm (2 in.).
- 1.23. ASHRAE 90.1
- 1.23.1. Provide mechanical equipment that complies with the minimum efficiency standards set out in ASHRAE 90.1 "Energy Standard for Buildings Except Low-rise Residential Buildings" and the National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.
- 1.24. HOISTING FACILITIES
- 1.24.1. Provide hoisting facilities for the Work of this Division.
- 1.24.2. Hoisting facilities provided by the General Contractor may be available for Subcontractor's use. If the General Contractor's hoisting facilities are inadequate, provide hoisting facilities for the Work of this Division. Coordinate requirements with the General Contractor prior to submission of Bid.

1.25. INTELLECTUAL PROPERTY

1.25.1. The Contractor acknowledges, represents, warrants and agrees that the Owner, its Consultants, and the Engineer's Representative are not responsible, and are hereby indemnified against any action as a result of patent infringement made through the review, acceptance, or receipt of materials, equipment, Work, etc. provided by the Contractor or any of their Suppliers or manufacturers in the execution of this Contract.

1.26. MATERIALS AND EQUIPMENT

- 1.26.1. Use new materials and equipment as specified or shown that are free from defects that impair strength, durability, or aesthetics.
- 1.26.2. Manufacture in Canada wherever possible.
- 1.26.3. Labelled and/or Listed as required by the Authority Having Jurisdiction or Code.
- 1.26.4. Mechanical systems are designed and coordinated based on the manufacturer and model number and/or parameters indicated on the Equipment Schedules in mechanical drawings. Accept all costs for differences in physical properties or performance between scheduled equipment and acceptable alternative equipment manufacturers or models identified in these Specifications. Differences may include, but are not limited to, size, layout, arrangement of components, connection sizes, maintenance access, locations and/or quantity of service connections, and performance differences such as noise, power consumption, flow rates, etc.
 - .1 Electrical coordination: accept all extra costs to revise the electrical provisions, including but not limited to feeder/wiring sizes, breaker sizes, fuse sizes, starters and equipment, to supply power to the non-basis of design piece of equipment.
- 1.26.5. Be responsible for all design costs associated with differences between scheduled equipment and alternate manufacturers or models identified in these Specifications.

1.27. LIFE SAFETY INTEGRATION TESTING

- 1.28. Provide testing of the integration of all life safety and fire protection systems.
- 1.28.1. The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems" as it relates to any mechanical systems.
- 1.28.2. The ITC and development of the ITP are not the responsibility of this Contractor.
- 1.28.3. The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
 - .1 Fire Alarm (e.g. mechanical systems integrated with or controlled by fire alarm system dampers, fan start up, fan shut down, make up air, pressurization, etc.)
 - .2 Prevention of Smoke Recirculation (AHUs)
- 1.28.4. Coordinate with all other trades to carry out the appropriate testing.
- 1.28.5. Be responsible for carrying out and coordinating the testing Work associated with the ITP. Coordinate all Work with the ITC and include but not be limited to the following:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.
 - .4 Provide all other documentation requested by the ITC as it relates to the mechanical systems in conformance with CAN/ULC-S1001.

1.29. VALUATION OF CHANGES

- 1.29.1. Further to Contract requirements, use the following method in determining the value of a change to the Work, by either Change Order or Change Directive:
 - .1 Estimate and acceptance in a lump sum, unless the Engineer's Representative otherwise determines that the method shall be unit prices set out in the Contract.
- 1.29.2. Provide the Engineer's Representative with a detailed cost analysis of the proposed change including:
 - .1 Quantity of each material.
 - .2 Unit cost of each material.
 - .3 Labour units based on Mechanical Contractors Association of America (MCAA) Labour Estimating Manual.
 - .4 Labour (hours) involved.
 - .5 Suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.
 - .6 Sub-trade quotations including a complete cost breakdown of the proposed change meeting the requirements of this section.
 - .7 Sub-trade's suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.
 - .8 Mark-ups, if applicable.
 - .9 Value of GST or HST, as applicable.
 - .10 Proposed change in contract time, if any.
 - .11 S+A proposed change number in every quotation to facilitate record keeping.
- 1.29.3. Comply with requirements of Contract Documents for all materials included in quotations for proposed changes.
- 1.29.4. List material and labour separately for each item/clause of the proposed change, on the detailed cost breakdown.
- 1.29.5. Not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under CCDC 2-2020 GC 6.2.
- 1.29.6. Inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the Work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide Owner immediately with any revised bonds or insurances.
- 1.29.7. Charge special equipment rental rates at cost. Provide an official quotation of the equipment rental with the proposed change quotation as backup, otherwise special equipment rentals will not be accepted by the Owner/Consultant.
- 1.29.8. The maximum percentage fee for mark-ups is as stated in the Division 0/1 specifications or Contract Supplementary Conditions.
- 1.29.9. All changes, change notices, proposed changes, revisions to contract, Supplemental Instructions, Change Directives or any additional costs or deletes to the stipulated lump sum Contract Price are subject to review and scrutiny by a qualified third party or individual.

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- 1.29.10. Use material costs based on a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The Owner and/or Engineer's Representative reserve the right to negotiate material pricing to a value that is fair and reasonable to the Owner.
- 1.29.11. Base the hourly labour rate for all changes on a Journeyperson rate as listed on the Bid Form and/or Supplementary Bid Form. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit.
- 1.29.12. At the request of the Owner or the Engineer's Representative, submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate to show how the Contractor has come to the proposed hourly rate. The Owner and the Engineer's Representative reserve the right to negotiate the hourly labour rate with the Contractor.
- 1.29.13. When pricing additional work for proposed changes, only price new materials that are required for the proposed change. Where existing materials and/or infrastructure can be re-used for the proposed change, utilize these items in the valuation of the change at no extra cost.
- 1.29.14. Where a proposed change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.29.15. When pricing proposed changes containing both additions and credits, and where no work and/or materials have been installed on site, only price the net new materials and net new labour that are required for the proposed change. Utilize equal per unit labour and material costs for credits and additions.
- 1.29.16. Utilize equal per unit labour and material costs for credits and additions.

1.30. STATEMENT OF PRICES

- 1.30.1. To form a basis for progress payments, submit a sample progress draw for the various portions of the work. Provide sample progress draw format matching that shown in the example progress draw below. As part of the sample progress draw which are relevant to the project. Break down the categories to clearly illustrate the value of the material being supplied as the first subcategory and the value of the labour being supplied as the second subcategory, as shown on the example progress draw. Provide further material and labour breakdowns by floor, area, or phase if the project sequencing or schedule focuses on distinct areas, one at a time. The Engineer's Representative reserves the right to request that additional categories be added to the progress draw if the Engineer's Representative feels that doing so will aid in assessing the Contractor's progress on site, thereby expediting Contractor payment. Progress draws not including the categories shown on the example progress draw where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
- 1.30.2. Ensure that the total price of all portions of the work equals the total price of the work covered under the Mechanical Division. Present cost for as-built drawings and O&M manuals as separate line items as shown below. Present line items from Section 20 08 00.00 COMMISSIONING as shown below.
- 1.30.3. List and track each of the approved changes on separate lines on the progress draw.
- 1.30.4. Amortize costs of temporary facilities and utilities over the duration of the Work. Claims for 'mobilization,' 'bidding costs,' or similar lump sums at or before start of Work are not acceptable.

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EXAMPLE PROGRESS DRAW

Mechanical Contractor Name

Billing Application Mechanical Division

Project Name

Application Number – x	x
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Date – xxxx to xxxx

<u>Description</u> Permits	<u>Contract</u> <u>Value</u> xxx,xxx.xx	<u>%</u> xxx	<u>Billed</u> <u>To Date</u> xxx,xxx.xx	<u>%</u> xxx	Prev. Billed xxx,xxx.xx	<u>%</u> xxx	<u>This</u> <u>Billing</u> xxx,xxx.xx	Balance to Complete xxx,xxx.xx
Demolition & removals	xxx,xxx.xx	ххх	xxx,xxx.xx	xxx	xxx,xxx.xx	ххх	XXX,XXX.XX	xxx,xxx.xx
Plumbing piping – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx,xxx.xx
Plumbing piping – Labour	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX,XXX.XX
Plumbing fixtures – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX	XXX,XXX.XX	XXX,XXX.XX
Plumbing fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	XXX,XXX.XX	xxx,xxx.xx
Plumbing equipment – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX	xxx,xxx.xx	xxx,xxx.xx
Plumbing equipment – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX	xxx,xxx.xx	xxx,xxx.xx
Drainage piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	XXX,XXX.XX	xxx,xxx.xx
Drainage piping – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
Drainage pumps – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	XXX	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx,xxx.xx
Drainage pumps – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	XXX	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx,xxx.xx
Fire protection piping – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx	XXX,XXX.XX	XXX,XXX.XX
Fire protection piping – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX	xxx,xxx.xx	xxx,xxx.xx
Fire protection valves / equipment – Materials	xxx,xxx.xx	xxx	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
Fire protection valves / equipment – Labour	xxx,xxx.xx	xxx	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
HVAC piping – Materials	xxx,xxx.xx	ххх	xxx,xxx.xx	XXX	xxx,xxx.xx	ххх	XXX,XXX.XX	xxx,xxx.xx
HVAC piping – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ХХХ	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx,xxx.xx
HVAC ductwork – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	ХХХ	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx,xxx.xx
HVAC ductwork – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
HVAC equipment – Materials	XXX,XXX.XX	XXX	XXX,XXX.XX	XXX	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx,xxx.xx
HVAC equipment – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
Building Automation System raceways and wiring – Materials	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
Building Automation System raceways and wiring – Labour	xxx,xxx.xx	ХХХ	XXX,XXX.XX	ХХХ	XXX,XXX.XX	ХХХ	XXX,XXX.XX	XXX,XXX.XX
Building Automation System equipment – Materials	xxx,xxx.xx	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System equipment – Labour	xxx,xxx.xx	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	xxx,xxx.xx
Heat tracing – Materials	XXX,XXX.XX	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	xxx,xxx.xx
Heat tracing – Labour	XXX,XXX.XX	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	xxx,xxx.xx

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Gas service – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ХХХ	xxx,xxx.xx	XXX,XXX.XX
Gas service – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	xxx,xxx.xx
Gas piping – Materials	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	xxx,xxx.xx
Gas piping – Labour	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	XXX,XXX.XX
Water service – Materials	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	XXX,XXX.XX
Water service – Labour	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	XXX,XXX.XX
Fuel oil system – Materials	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX,XXX.XX
Fuel oil system – Labour	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	XXX,XXX.XX
Excavation and backfill – Materials	XXX,XXX.XX	ХХХ	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx,xxx.xx
Excavation and backfill – Labour	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	xxx,xxx.xx
Shop Drawings (0.5 % of contract value)	xxx,xxx.xx	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	xxx,xxx.xx	xxx,xxx.xx
Installation review and equipment verification (0.5 % of contract value)	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx	XXX,XXX.XX	XXX,XXX.XX
Plumbing and drainage system testing (0.5 % of contract value)	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX,XXX.XX
Testing of piping systems (0.5 % of contract value)	XXX,XXX.XX	xxx	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx,xxx.xx
Assistance with Independent Contractor balancing of piping systems (0.25 % of contract value)	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX,XXX.XX
Testing of air systems (0.5 % of contract value)	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
Assistance with Independent Contractor balancing of air systems (0.25 % of contract value)	XXX,XXX.XX	XXX	XXX,XXX.XX	XXX	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx,xxx.xx
System start-up (0.5 % of contract value)	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	xxx,xxx.xx	XXX	XXX,XXX.XX	XXX,XXX.XX
Commissioning / Testing (3% of contract value)	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	xxx	XXX,XXX.XX	xxx,xxx.xx
Operating & Maintenance Manuals (0.5 % of contract value)	xxx,xxx.xx	ХХХ	xxx,xxx.xx	ХХХ	xxx,xxx.xx	XXX	xxx,xxx.xx	xxx,xxx.xx
Training (0.5 % of contract value)	XXX,XXX.XX	ххх	XXX,XXX.XX	ХХХ	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx,xxx.xx
As-Built Drawings (0.5 % of contract value)	XXX,XXX.XX	ХХХ	XXX,XXX.XX	ХХХ	XXX,XXX.XX	XXX	XXX,XXX.XX	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	ххх	XXX,XXX.XX	ХХХ	xxx,xxx.xx	Ххх	XXX,XXX.XX	xxx,xxx.xx
Subtotal	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	ххх	XXX,XXX.XX	XXX,XXX.XX
Additions to Contract						1		
CO # / PC # / CCN #	xx,xxx.xx	ххх	XX,XXX.XX	ххх	XX,XXX.XX	ххх	XX,XXX.XX	xx,xxx.xx
Contingency #	XX,XXX.XX	ххх	XX,XXX.XX	ххх	XX,XXX.XX	ххх	xx,xxx.xx	XX,XXX.XX
Subtotal	xx,xxx.xx	XXX	XX,XXX.XX	XXX	XX,XXX.XX	XXX	XX,XXX.XX	XX,XXX.XX

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Total Contract	XXX,XXX.XX	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	ххх	xxx,xxx.xx	XXX,XXX.XX
Less Holdback			XXX,XXX.XX		XXX,XXX.XX		XXX,XXX.XX	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

- 2. Products
- 2.1. NOT USED
- 3. Execution
- 3.1. NOT USED

20 05 01.00 Abbreviations

- 1. General
- 1.1. ABBREVIATIONS
- 1.1.1. The following list of common abbreviations and acronyms may be utilized in the Contract Documents or in the execution of the Work. The list is considered general in nature and all abbreviations or acronyms identified may not apply to the specific Work required to be completed. The list is not exhaustive and some abbreviations or acronyms may be the same however represent different denotation (e.g. BHP - Boiler Horsepower and BHP - Brake Horsepower) and must be read in the context of the Section the abbreviation or acronym is written in. A Section may define alternative abbreviations or acronyms that take precedence in the execution of the Work of that Section.

AABC	-	Associated Air Balance Council
AAP	-	Alarm Annunciator Panel
ABMA	-	American Boiler Manufacturers Association
AC	-	Alternating Current
ACO	-	Acid Resistant Cleanout
AD	-	Acid Resistant Drains
AFD	-	Acid Resistant Floor Drain
AFF	-	Above Finished Floor
AGA	-	American Gas Association
AMCA	-	Air Movement and Control Association
ANSI	-	American National Standards Institute
AHRI	-	Air-Conditioning, Heating and Refrigeration Institute
ASCE	-	American Society of Civil Engineers
ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AV	-	Acid Resistant Vent
AWG	-	American Wire Gauge
AWS	-	American Welding Society
AWWA	-	American Water Works Association
BHP	-	Boiler Horsepower or Brake Horsepower
Btu/hr	-	British Thermal Units per Hour
BWG	-	British Wire Gauge
CAD	-	Computer Aided Drafting
CAFV	-	Controllable Air Flow Venturis
CAP	-	College of American Pathologists
CBC	-	California Building Code
CCA	-	Chromated Copper Arsenate
CEMA	-	Canadian Electrical Manufacturer's Association
CEMS	-	Central Energy Management System

CCF	-	Central Computer Facility
CCMC	-	Canadian Construction Materials Centre
cfm	-	Cubic Feet per Minute
CGA	-	Canadian Gas Association
CGSB	-	Canadian General Standards Board
CI	-	Cast Iron
CIMJ	-	Cast Iron Mechanical Joint
CPU	-	Central Processing Unit
CRN	-	Canadian Registration Number
CSA	-	Canadian Standards Association
cu.ft.	-	Cubic Feet
cu.m.	-	Cubic Meter
c/w	-	Complete with
db	-	Dry Bulb
dB	-	Decibel
dBA	-	A-weighted Decibel
DC	-	Direct Current
DDC	-	Direct Digital Control
DegC	-	Degrees Celsius
DegF	-	Degree Fahrenheit
dia.	-	Diameter
DPDT	-	Double Pull Double Throw
DPTX	-	Differential Pressure Transmitters
EAP	-	Excess Exhaust Alarm Panel
EDR	-	Equivalent Direct Radiation
EF	-	Exhaust Fan
EEMAC	-	Electrical Equipment Manufacturers Association of Canada
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
EMT	-	Electrical Metallic Tubing
EP	-	Electric Pneumatic
EPDM	-	Ethylene Propylene Diene-Rubber
EPROM	-	Electrically Programmable Read Only Memory
ERW	-	Electric Resistance Welded
FACP	-	Fire Alarm Control Panel
FDA	-	Food and Drug Administration
FHC	-	Fume Hood Controller or Firehose Cabinet
FLA	-	Full Load Amps
fpm	-	Feet per Minute
fps	-	Feet per Second
FM	-	Factory Mutual
ft.	-	Foot or Feet
ga	-	Gauge
gal	-	Gallons

GFD	-	Gallons per Square Feet per Day
GPD	-	Gallons per Day
GPH	-	Gallons per Hour
GPM	-	Gallons per Minute
GS	-	Galvanized Steel
GSG	-	Galvanized Sheet Gauge
GSS	-	Galvanized Sheet Steel
h-cu.ft.	-	Hour-cubic foot HCFCs - Hydrochlorofluorocarbons
HEPA	-	High Efficiency Particulate Air
HOA	-	Hand/Off/Auto
HOT	-	Hand Held Operator Terminal
HSS	-	Hollow Steel Sections or Hollow Structural Sections
HTK	-	Hood Termination Kit
hp	-	High Pressure or Motor Horsepower
Hz	-	Hertz
IAO	-	Insurers' Advisory Organization
IAOC	-	Insurers' Advisory Organization of Canada
IBC	-	International Building Code
ICU	-	Intensive Care Unit
(I)GPH	-	(Imperial) Gallons per Hour
(I)GPM	-	(Imperial) Gallons per Minute
in.	-	Inch or Inches
in. WG	-	Inches of Water Gauge
IRMA	-	Inverted Roof Membrane Assembly
kg	-	Kilogram
kg/cu.m.	-	Kilogram per cubic meter
kPa	-	Kilopascals
kVa	-	Kilovolt-amps
kW	-	Kilowatts
lbs/cu.ft.	-	Pounds per cubic foot
lbs/hr.	-	Pounds per Hour
L	-	Litre
L/s	-	Litres per Second
LFC	-	Laminar Flow Cabinets
LEDs	-	Light Emitting Diodes
LCP	-	Laboratory Control Panel
LTF	-	Linear foot
LM	-	Linear meter
mA	-	Milliamps
MAC	-	Make-up Air Controller
mADC	-	Milliamps Direct Circuit
MBH	-	1000 British Thermal Units per Hour
MCC	-	Motor Control Centre

mm	-	Millimetre
m	-	Metre
m/s	-	Metres per Second
mL	-	Millilitre
MCP	-	Motor Control Panel
MJ	-	Mechanical Joint
MOV	-	Motor Overvoltage
mPa	-	Millipascals
MSC	-	Master Summing Controller
MSG	-	Manufacturers' Standard Gauge
NADCA	-	National Air Duct Cleaners Association
NBS	-	National Bureau of Standards
NC	-	Noise Criterion as Defined by Graph in ASHRAE
NCCLS	-	National Committee for Clinical Laboratory Standard
NEMA	-	National Electrical Manufacturers Association
NFPA	-	National Fire Protection Association
NIM	-	Network Interface Module
NIST	-	National Institute of Standards and Technology
NIOSH	-	National Institute of Occupancy Safety and Health
NPS	-	American National Standard Straight Pipe Thread
NPSH	-	Net Positive Suction Head
NPT	-	American National Standard Taper Pipe Thread
No.	-	Number
NST	-	National Standard Thread
NVLAP	-	National Voluntary Laboratory Accreditation Program
OAT	-	Outside Air Temperature
OC	-	On Centre
OCP	-	Operator Control Panel
OPSS	-	Ontario Provincial Standard Specification
OS&Y	-	Outside Screw and Yoke
OWRA	-	Ontario Water Resources Act
0Z.	-	Ounce or Ounces
PCU	-	Personal Computer Unit
PE	-	Pneumatic Electric
PIT	-	Portable Interface Terminal
ph	-	Hydrogen Ion Concentration
ppm	-	Part per Million
psf	-	Pounds per Square Foot
psi	-	Pounds per Square Inch
psia	-	Pounds per Square Inch Absolute
psig	-	Pounds per Square Inch Gauge
PWM	-	Pulse Width Modulation
PVC	-	Polyvinyl Chloride

qt.	-	Quart
RAH	-	Return Air Humidity
RH	-	Relative Humidity
RO	-	Reverse Osmosis
rpm	-	Revolutions per Minute
RPU	-	Remote Processing Unit
RPU-TU	-	Remote Processing Unit for Terminal Units
SCFH	-	Standard Cubic Feet per Hour
SCMH	-	Standard Cubic Meters per Hour
SCR	-	Silicone Controlled Rectifier
SI	-	International System of Units
SMACNA	-	Sheet Metal and Air Conditioning Contractors' National Association
sp. in. wg.	-	Static Pressure, Inches Water Gauge
SPDT	-	Single Pull Double Throw
SPS	-	Sash Position Sensor
SS	-	Stainless Steel
SF	-	Supply Fan
SPWM	-	Sine-Coded Pulse Width Modulated
SSPC	-	Steel Structures Painting Council (The Society of Protective Coatings)
sq.m.	-	Square Meter
STC	-	Supply/Exhaust Tracking Controller or Sound Transmission Class
SWS	-	Sidewall Velocity Sensors
TDS	-	Totally Dissolved Solids
TEFC	-	Totally Enclosed Fan Cooled
TIG	-	Tungsten Inert Gas
TKV-TWA	-	Threshold Limit Value - Time Weighted Average
UACU	-	Unitary Air Conditioning Units
UL	-	Underwriter's Laboratories
ULC	-	Underwriter's Laboratories of Canada
Ohm	-	Ohm
USP	-	United States Pharmacopeia
USG	-	United States Gallons
USGPH	-	United States Gallons per Hour
USGPM	-	United States Gallons per Minute
UV	-	Ultraviolet
VAC	-	Volts Alternating Current
VDC	-	Volts Direct Current
VFD	-	Variable Frequency Drive
VSC	-	Variable Speed Controllers
VSCFH	-	Closed Loop Variable Frequency Drives For Dedicated Exhaust Hoods
VSD	-	Variable Speed Drives
W	-	Watt
W/cu.m.	-	Watts per Cubic Meter

W/ft.	- Watts per Foot
W/m	- Watts per Meter
W/sq.in.	- Watts per Square Inch
W/sq.m.	- Watts per Square Meter
WC	- Water Closet
wb	- Wet Bulb
wg	- Water Gauge
WHMIS	- Workplace Hazardous Material Information System
WSP	- Working Steam Pressure
WOG	- Water, Oil, Gas

- 2. Products
- 2.1. NOT USED
- 3. Execution
- 3.1. NOT USED

20 05 02.00 As-built drawings

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. RELATED WORK SPECIFIED ELSEWHERE
- 1.2.1. Refer to as-built drawings in Section 01 70 00.00 (01 72 29.00) CLOSEOUT SUBMITTALS.
- 1.3. RECORD OF REVISIONS ON SITE
- 1.3.1. Print and maintain two complete sets of white prints to mark the Project progress, changes and deviations.
- 1.3.2. Maintain an updated copy of plans and schematics in the digital format for which the Project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.
- 1.4. SUBMITTALS
- 1.4.1. Submit as-built drawings in Revit/CAD format and PDF format for underground services for review prior to slab pour.
- 1.4.2. Submit as-built drawings in Revit/CAD format and PDF format for all other areas of the building prior to request for occupancy.
- 1.4.3. Comply with Section 20 05 03.00 SHOP DRAWINGS for all submittals.
- 2. Products
- 2.1. NOT USED
- 3. Execution
- 3.1. DOCUMENTATION REQUIREMENTS
- 3.1.1. As the Project progresses record all changes and deviations.
- 3.1.2. Maintain an accurate dimensional record of revisions. Specifically record:
 - .1 Underground piping invert elevations and pipe locations dimensioned to column lines after review and acceptance by the Authority Having Jurisdiction.
 - .2 Inverts of underground piping at building exit and entry, below floor slab at each branch connection, riser base, and change in direction as well as a least 3 points on long straight runs.
 - .3 Above ground piping revisions.
 - .4 Duct revisions.
 - .5 Equipment revisions.

- .6 Locations of access doors and panels. Identify the equipment and components they serve.
- .7 Locations of valves.
- 3.1.3. Keep revisions up-to-date during construction including Change Orders, Change Directives, and Supplemental Instructions. Documentation shall be available for review at all times.
- 3.1.4. Final as-built documents shall not contain markings or corrections electronically or by hand (i.e. marker, pen, pencil, etc.). Drawings submitted that contain mark-ups will not be accepted.
- 3.2. SUBMISSION REQUIREMENTS
- 3.2.1. On completion of the Work, submit the draft documentation indicating all such changes and deviations for review by the Engineer's Representative. Submit all documents in PDF format.
- 3.2.2. Upon return of the "Reviewed" draft submittal, transfer "as-built" information and any additional submittal comments to the final software submission requirement (i.e. Autodesk AutoCAD or Autodesk Revit MEP).
 - .1 Request the acceptable version(s) of the software that may be used. Owner shall confirm the acceptable software version upon receipt of request. If the Owner has no preference, the latest published version shall apply.
 - .2 Conform to the Owner/Engineer's Representative's standards.
 - .3 The Mechanical Contractor may request from the Engineer's Representative the most current electronic documentation in AutoCAD. Documents to be forwarded via a secure file transfer.
 - .4 Clearly label electronic files with Engineer's Representative and Owner, Contract number, file names and the Drawing number.
- 3.2.3. Submit the documents in PDF along with the submission of the completed electronic source software documentation on an approved electronic storage device for review by the Engineer's Representative.
- 3.2.4. If required, the Engineer's Representative will provide a quotation to this Contractor to transfer "as-built" information from the mark-up documentation to the acceptable software.
 - .1 Include a cost of \$400.00 per sheet for the transfer of marked up "as-built" information to AutoCAD and forwarding of the mechanical information by the Engineer's Representative to the Owner.
- 3.2.5. The Project will remain incomplete and monies retained until a satisfactory as-built submission is provided.

3.3. AUTOCAD SPECIFIC SUBMISSION REQUIREMENTS

- 3.3.1. Submit a complete list of layer names and brief description of each layer's use with all files.
- 3.3.2. Submit a complete list of symbol (block) names with a description of each symbol.
- 3.3.3. Make special effort 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 that entities are placed on correct layers.
- 3.3.4. Use the standard fonts available in the software. Do not use custom fonts, shape files, etc.
- 3.3.5. Provide all drawings in the same scale of measurement and units as issued on Bid Documents.

20 05 03.00 Shop Drawings

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. RELATED WORK SPECIFIED ELSEWHERE
- 1.2.1. Comply with Section 01 33 00.00 (01 33 23.00) for Submittals except as amended below.
- 2. Products

2.1. SHOP DRAWINGS

- 2.1.1. Submit Shop Drawings organized by Specification Section. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate Shop Drawings for the same Specification Section. Do not combine more than one Specification Section into one submission. Incorrect submissions will be returned without review.
- 2.1.2. Submit Shop Drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:
 - .1 S+A Project number and Contractor Shop Drawing Identifier in Subject Line
 - .2 Attachments shall be limited to 20MB
 - .3 Provide FTP hyperlink for all attachments in excess of 20MB with appropriate information for downloading the file (as required)
 - .4 Shop Drawing Submission to the following email address:
 - .1 tony.ying@smithandandersen.com
 - .2 chris.pappas@smithandandersen.com
- 2.1.3. Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.
- 2.1.4. 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 Drawing shall give the identifying number as noted in the documents of the specific pump, fan, etc. for which it was prepared.
- 2.1.5. 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.
- 2.1.6. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation. The Engineer's Representative may also request that this information be added to the maintenance and operating manual.

- 2.1.7. 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 Engineer's Representative.
- 3. Execution

3.1. SUBMISSIONS

- 3.1.1. Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the submission for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have 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 Shop Drawings for review.
- 3.1.2. Scanned PDF versions are not acceptable.
- 3.1.3. Manufacturing of equipment, installation of equipment or connecting services shall not start until after final review of Shop Drawings by the Engineer's Representative has been completed.

20 05 05.00 Selective Demolition for Mechanical Services

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. These Specifications are an integral part of the Contract Documents and apply to all Division 20, 22 and 23 Sections.
- 1.1.3. Provide labour, materials, products, equipment and services required to complete the decommissioning and/or demolition Work specified herein.
- 1.1.4. Refer to Drawings for extent of decommissioning and/or demolition Work. The Drawings indicate the approximate locations of services as far as these are known. The Drawings do not necessarily represent the full extent of the installed service(s) to be removed and are inferred to include decommissioning of all pipes, valves, fittings, appurtenances, etc. except where a service or component is explicitly identified to remain as an abandoned service.
 - .1 For decommissioning and demolition of all services within a floor or identified area, refer to as-built drawings for reference for additional detail as required.
 - .2 Where full removal of services or equipment is required and existing as-built drawings are not available, review the service locations on site, plan the removal to avoid disruption or accidental discharge from services, and mark all services for demolition with colour coding as required for phased removal.
- 1.1.5. Dispose of all debris offsite in accordance with the jurisdictional authorities.
- 1.1.6. Remove and pay for the disposal of refrigerants, oils, glycol, or similar materials in accordance with all municipal by-law or code requirements.
- 1.1.7. Remove and store salvageable items as directed herein or indicated on Drawings.
- 1.1.8. Mechanical decommissioning and/or demolition Work associated with this building is indicated on the Mechanical Drawings and generally consists of the following:
 - .1 Rooftop units including all ducts, pipes, controls, and appurtenances.
 - .2 Domestic Hot Water Heater including all venting, water distribution, natural gas distribution, domestic water piping, etc.
 - .3 Remove services in a staged or phased approach to allow for immediate repair or service replacement where required to temporarily maintain the integrity of the building envelope against weather, etc.

1.2. REFERENCE STANDARDS

- 1.2.1. Meet the requirements of all Municipal, Provincial and Federal By-laws and Ordinances for the Province and Municipality for the Place of the Work.
- 1.2.2. Execute this Work in accordance with the latest or in force edition of the following codes and standards:
 - .1 Ontario Building Code.
 - .4 Occupational Health and Safety Act.
 - .5 Regulations for Construction Projects.
 - .6 Ontario Fire Code.

- .7 National Fire Code of Canada.
- .10 Regulations under Fire Protection and Prevention Act.
- .11 Technical Standards and Safety Authority (TSSA).
- 1.3. SUBMITALS
- 1.3.1. Submit Shop Drawings as requested by the Engineer's Representative, indicating demolition sequence, cutting and patching, bracing and protection of existing services designated to remain.
- 1.3.2. Comply with Section 01 33 00.00 (01 33 23.00) for Submittals except as amended below.
- 1.3.3. Comply with Section 20 05 03.00 SHOP DRAWINGS.

1.4. QUALITY ASSURANCE

- 1.4.1. Provide adequate equipment and skilled labour with appropriate certifications suitable to the demolition task.
- 1.4.2. Remove from site and dispose of debris, refrigerants, oils, etc. in accordance with the requirements of the Authority Having Jurisdiction.
- 1.4.3. Arrange and pay for all permits, notices and inspections necessary for the proper execution and completion of the demolition Work.
- 1.4.4. Decommissioning of special equipment, where noted on the Mechanical Drawings, must be provided by the equipment manufacturer.
- 1.4.5. Review and sign off on all demolition Work prior to demobilization of demolition trades. Any associated costs due to failure to review and sign off on demolition Work will be the responsibility of the Mechanical Contractor.

2. Products

2.1. DISPOSAL OF MATERIALS

- 2.1.1. Except as required by Law for disposal, the Contractor may claim ownership of all materials which have not been designated for salvage from the demolition. Remove all material and debris from the site as quickly as possible and dispose of in a legal manner. Properly remove and dispose of all refrigerant and other toxic or hazardous materials. Burning of debris or selling of materials on site is not permitted. The Contractor is responsible for all future use (or misuse) of items once they have been removed from the installed location.
- 2.1.2. Conform to the requirements of the Municipality regarding disposal of waste materials.
- 2.1.3. Materials prohibited from municipality waste management facilities shall be removed from site and disposed to recycling companies specializing in recyclable materials.

2.2. SALVAGEABLE ITEMS TO BE REMOVED AND STORED

- 2.2.1. The following is a list of salvageable items to be carefully disconnected, removed and turned over for storage for future use:
 - .1 NONE.

3. Execution

3.1. GENERAL INSTRUCTIONS

- 3.1.1. At the end of each Work shift, leave Work in a safe condition.
- 3.1.2. Demolish Work into sections of practical size for removal without alteration or damage to existing building structure or finishes that are indicated to remain.
- 3.1.3. Demolish Work in sections, replacing with new materials as required, for services to remain in operation during the demolition and construction process. This may include, but is not limited to systems such as storm drainage, sanitary drainage, etc.

3.2. STORAGE OF MATERIALS

- 3.2.1. Store materials only in areas designated and as permitted by owner prior to construction start.
- 3.2.2. Do not stack materials and debris in the building to the extent that overloading of any part of the structure will occur.

3.3. PROTECTION OF PREMISES

- 3.3.1. Adhere strictly to the Owner's requirements.
- 3.3.2. Adhere strictly to the requirements for heritage preservation.
- 3.3.3. Adhere to an agreed upon schedule for dust and noise control prior to commencing Work in or adjacent to existing facilities where such Work might affect other facilities or their occupants.
- 3.3.4. Execute Work with least possible interference or disturbance to the building occupants, public, and normal use of adjacent premises.
- 3.3.5. Provide temporary means to maintain security when security has been reduced by this Contractor.
- 3.3.6. Utilize only elevators, dumbwaiters, conveyors or escalators assigned for Contractor's use for moving workers and material within the building. Protect walls of passenger elevators prior to use. Accept liability for damage, safety of equipment and overloading of existing equipment.
- 3.3.7. Provide temporary dust screens, barriers, warning signs in locations where renovations and alteration Work is adjacent to public areas which will be operative during Work.
- 3.3.8. Protect all heritage or other mechanical systems indicated to remain against damage.
- 3.3.9. Provide and maintain ready access to firefighting equipment at all times.
- 3.3.10. Provide and maintain proper and suitable fire extinguishers throughout the duration of the Work.
- 3.3.11. The Drawings indicate the approximate locations of services, as far as these are known. Should any mechanical or electrical service that is anticipated to remain in place (i.e. storm drainage) be broken or disrupted by operations specified under this contract, repair the service and make good all damage. Temporarily remove and replace all services or parts of services to permit the full removal of services identified.
- 3.3.12. The existing Drawings and/or as-built drawings indicate the approximate locations of services as far as these are known. Where specific services are identified for removal within an area of Work, immediately advise the Engineer's Representative in writing when unknown or unexpected services are encountered. Investigate and clearly document these services back to their source, as required, to facilitate further direction regarding removal.
- 3.3.13. Accept liability for costs incurred by the Owner in repairing and cleaning equipment, etc., resulting from failure to comply with the above requirements.

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3.4. RESTRICTIONS REGARDING USE OF PREMISES

- 3.4.1. Use only those existing entrances and stairs designated for access to and egress from the existing buildings and various floors where Work of this contract is to be carried out. No traffic through other areas of the building will be permitted without the prior consent of the Owner.
- 3.4.2. Keep stairs and corridors clear and open as required for exit purposes in case of fire, and as required for use by the Contractor's personnel.

3.5. PREPARATION

- 3.5.1. Prior to commencing this Work, arrange to have the appropriate trades present to disconnect all utility services where required.
- 3.5.2. Drain completely all gravity or pressurized water services to avoid damage or hazard due to accidental discharge. Where sections of the installed services cannot be drained fully utilizing existing valves, drain connections, etc., open the service and control the discharge of water appropriately to avoid discharge during service removal.
- 3.5.3. Identify and protect all existing services designated to remain.
- 3.5.4. Carry out pre-construction air flow measurement on each rooftop unit within the building, provide a detailed summary prior to demolition. Air flow rate before and after replacement of rooftop units shall be improved as per facilities preference or remain unchanged.

3.6. INTERRUPTION OF EXISTING SERVICES TO REMAIN

- 3.6.1. Arrange, schedule and perform Work to mitigate disturbance to existing facilities and services.
- 3.6.2. Submit a complete master schedule of anticipated service interruptions and changeovers with approximate dates required, durations and times of day, for approval by the Owner before proceeding with any Work. Update and submit the schedule on a weekly basis during construction.
- 3.6.3. Notify the Owner in writing at least 72 hours in advance (unless specified elsewhere) of the planned interruption of existing services that are to remain.
- 3.6.4. Interruption of services must occur at the times and for the duration stipulated by the Owner.
- 3.6.5. Keep service interruption duration to an absolute minimum. Carry out all preparatory Work, measurements, etc., without interruption of existing services where possible.
- 3.6.6. The following service interruptions are required to be performed after business hours or on weekends, etc. Include all required costs to complete the Work during this time:
 - .1 Rooftop Unit Replacement
 - .2 Domestic Hot Water Heater Replacement

3.7. PARTIAL REMOVAL OF A SERVICE

- 3.7.1. Remove services back to the main (service pipe or duct) or nearest branch (pipe or duct) serving other areas to remain. Cap services tight to the main or branch.
- 3.7.2. Do not abandon unused services in the ceiling space, furred walls, shafts, etc. unless expressly permitted by the Engineer's Representative or Owner.
- 3.7.3. Where an unused service is indicated or permitted to remain, mark the abandoned services clearly including the service type (i.e. Do Not Connect Abandoned Chilled Water).

20 05 14.00 Wiring and Starters

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. All power and control wiring from starters and fused and non-fused disconnect switches, whether mounted in MCCs or individually, to all mechanical devices and equipment shall be provided by this Division except where shown and specified under the Electrical Division.
- 1.1.3. All starters for devices supplied by this Division shall be provided by this Division except where shown and specified under the Electrical Division.

1.2. RELATED WORK SPECIFIED ELSEWHERE

- 1.2.1. All power wiring and starters for devices supplied by this Division shall be provided by the Electrical Division except where shown and specified under this Division. All control wiring shall be provided by this Division.
- 1.2.2. Where starters for skid mounted, packaged equipment are provided by this division they shall meet the requirements of the Electrical Division.

1.3. REFERENCES

- 1.3.1. IEC 60947-4-1 "Low-voltage switchgear and controlgear Part 4-1: Contactors and motorstarters - Electromechanical contactors and motor-starters" latest edition.
- 1.3.2. CSA C22.2 No. 60947-4-1 "Low-voltage switchgear and controlgear Part 4-1: Contactors and motor-starters Electromechanical contactors and motor-starters (Bi-national standard with UL 60947-4-1)" latest edition.
- 1.3.3. CSA C22.2 No. 4 "Enclosed and dead-front switches (Tri-national standard with NMX-J-162-ANCE-2016 and UL 98)" latest edition.
- 1.3.4. CSA C22.2 No. 39 "Fuseholder assemblies" latest edition.

1.4. SUBMITTALS

- 1.4.1. Further to the requirements of Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03.00 SHOP DRAWINGS, submit Shop Drawings of the following for Individual Starters:
 - .1 Submit an overload thermal element list with all supporting data for review prior to installation of the elements.
 - .2 Submit samples of nameplates for review before manufacturing.
 - .3 Mounting method and dimensions.
 - .4 Starter size and type.
 - .5 Layout of identified internal and front panel components.
 - .6 Enclosure types.
 - .7 Wiring diagram for each type of starter.
 - .8 Interconnection diagrams.

- 1.4.2. Further to the requirements of Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03.00 SHOP DRAWINGS, submit Shop Drawings of the following for Motor Control Centre:
 - .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned, position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.
 - .7 Size, capacity and labeling of all starters.
 - .8 Electrical ratings of MCC.
- 2. Products
- 2.1. DISCONNECT SWITCHES
- 2.1.1. Fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.
- 2.1.2. Provision for padlocking in on-off switch position by three locks.
- 2.1.3. Mechanically interlocked door to prevent opening when handle in ON position.
- 2.1.4. Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 FUSES LOW VOLTAGE.
- 2.1.5. Fuse-holders: suitable without adaptors, for type and size of fuse indicated.
- 2.1.6. Quick-make, quick-break action.
- 2.1.7. ON-OFF switch position indication on switch enclosure cover.
- 2.1.8. Equipment identification
 - .1 Provide equipment identification in accordance with Section 26 05 53.00 IDENTIFICATION.
 - .2 Indicate name of load controlled on nameplate.
 - .3 Provide a lamacoid nameplate that indicates the replacement fuse size as well as the maximum allowable fuse size for that disconnect switch based upon the sizing of the feeder.
- 2.1.9. MANUFACTURERS
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 Or approved alternate.
- 3. Execution
- 3.1. INSTALLATION

3.1.1.

- 3.1.2. Install disconnect switches in accessible locations which meet the electrical code requirements for working space with secure footing. Working space clearance envelope to be 1 m deep in front of disconnect switch, 1 m or disconnect switch width wide, whichever is greater, and 2.2 m high.
- 3.1.3. Ensure slack is provided in control wiring connections to control valves, dampers, differential pressure sensors, or other equipment with moving parts.
- 3.1.4. Ensure slack is provided in power wiring connections to control valves, dampers, differential pressure sensors, or other equipment with moving parts.
- 3.2. FIELD QUALITY CONTROL
- 3.2.1. Perform tests in accordance with Section 26 08 01.00 TECHNICAL SERVICES DIVISION START-UP SERVICE and manufacturer's written instructions. Contractor to oversee all testing and correct any deficiencies noted.
- 3.2.2. Operate switches, contactors to verify correct functioning.
- 3.2.3. Perform starting and stopping sequences of contactors and relays.
- 3.2.4. Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

20 05 19.00 Indicating Instruments

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Shop Drawings: Further to requirements of Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03.00 SHOP DRAWINGS, submit working ranges of thermometers and gauges with Shop Drawings.
- 2. Products

2.1. MATERIALS

- 2.1.1. Pipeline thermometers shall be complete with:
 - .1 Dust-tight stainless case and stem with 127 mm (5 in.) dial.
 - .2 Bi-metal type.
 - .3 White face with black lettering.
 - .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for hot water and -17 to 49 deg. C. (0 to 120 deg. F.) for chilled water but range shall suit maximum and minimum temperatures of location and be shown on Shop Drawings.
 - .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
 - .6 External recalibration adjustment.
 - .7 Separable socket with extension neck as required for insulated pipe.
 - .8 Universal adjustable hinge.
 - .9 Wells shall be registered with the provincial Boiler and Pressure Vessel Safety Branch and have a CRN.
- 2.1.2. Pressure gauges shall be complete with:
 - .1 Dust-tight nominal 115 mm (4½ in.) dia. case, solid front complete with back blow-out to ASME B40.100 "Pressure Gauges and Gauge Attachments", ASME B40.1 "Gauges: Pressure Indicating Dial Type Elastic Element" Grade 2A Level Standards.
 - .2 Back-flanged where required.
 - .3 Black pointer.
 - .4 White dial with black markings.
 - .5 Dial range to cover twice the average working pressure of the equipment and shall be compound gauges on pump suction for all open systems.
 - .6 Clear lens.
 - .7 Phosphor bronze bourdon tube, silver soldered.

- .8 Brass or stainless steel movement, bronze or nylon brushed, scale and movement mounted independent of the case.
- .9 Brass socket.
- .10 kPa and psi scales.
- .11 Provincial Boiler and Pressure Vessel Safety Branches registration number.
- .12 All wetted parts in contact with potable water systems shall be lead free.
- 2.1.3. Pressure and temperature test port:
 - .1 Continuous operating temperature range of -40 Deg. C. (-40 Deg. F.) to 65.6 Deg. C. (150 Deg. F.).
 - .2 Dual self closing Nordel valves for 135 Deg. C (275 Deg. F.) intermittent maximum operating temperature.
 - .3 2758 kPa (400 psig) maximum operating pressure.
 - .4 Threaded brass or 316 stainless steel body to suit service material.
 - .5 Screwed cap and gasket with retaining strap.
 - .6 Temperature and pressure test kit in protective carrying case with 2 thermometers, 1 pressure gauge and 2 adaptors for full range of service temperatures and pressures.
- 2.1.4. Thermometers shall be Trerice, Taylor, Weksler, Winters or Ashcroft.
- 2.1.5. Pressure gauges shall be Trerice, Ashcroft, Morrison, Winters or Weksler.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Locate all thermometers and pressure gauges so as to assure easy reading from the floor or platform.
- 3.1.2. Where direct reading instruments cannot be satisfactorily located use a remote instrument.
- 3.1.3. Locate remote instruments next to the point of the reading, on wall or structure.
- 3.1.4. Each remote or panel mounted instrument shall have an engraved lamacoid nameplate identifying the system and service.
- 3.1.5. Insert pipeline thermometer and/or pressure gauges into tanks, equipment tapings or in pipeline using screwed tees or forged steel couplings, welded into the pipe.
- 3.1.6. Provide thermometers in the following locations in pipelines:
 - .1 Each hot or cold water storage tank
 - .2 and where specifically shown
- 3.1.7. When a common supply header provides the same temperature water to more than one coil or zone, provide a thermometer on the common header only.
- 3.1.8. For control valves with by-pass, locate thermometer in common pipe to allow for manual temperature control.
- 3.1.9. Where a common duct or plenum provides the same temperature air to many zones, provide a thermometer on the common duct only, rather than at each branch of a zone.
- 3.1.10. Provide test wells for thermometers where shown. Test wells shall be compatible with the thermometers used. Wells shall be registered with the applicable Provincial Authority Having Jurisdiction and have a CRN.

- 3.1.11. Provide a ball valve on the inlet to each gauge. Install a pressure snubber on any gauge installed near a pump or in any location where damping is required to prevent rapid oscillation of the pointer. When the equipment is subject to vibration, mount the gauge on adjacent wall or on a mounting plate, supported from the floor.
- 3.1.12. Provide pressure gauges in the following areas (not permitted to be pressure and temperature test ports):
 - .1 and where specifically shown
- 3.1.13. Provide pressure gauges or pressure and temperature test ports in the following areas:
 - .1 and where specifically shown
- 3.1.14. Provide valved and capped connections for pressure gauges on each side of coils where pressure and temperature test ports are not provided.
20 05 29.00 Hangers and Supports

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 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 workpersonlike 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.
- 1.2. SUBMITTALS
- 1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 SHOP DRAWINGS.
- 2. Products

2.1. MATERIALS

- 2.1.1. Provide hangers and supports manufactured by Anvil ASC Engineered Solutions, Taylor Pipe Supports, or E. Myatt & Co.
- 2.1.2. All pipe hangers and supports shall be manufactured to the latest requirements of ANSI MSS-SP-58 "Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation." Where applicable, design and manufacture of hangers and supports shall also conform to ANSI/ASME B31 "Code for Pressure Piping."
- 2.1.4. For pipe and duct runs on the roof of the building, provide roof supports by Trikon Systems, MIRO Industries (Unistrut), Advanced Support Products Inc., or Portable Pipe Hangers Inc.
- 2.1.5. For pipe and duct runs on the roof of the building, anchor pipes and ducts to the building structure using supports by Thaler Roof Specialties or equal.
- 2.1.6. As an alternative to pipe and duct runs on the roof of the building being anchored to the building structure, provide support system design taking into account wind load review, stamped and signed by a Professional Engineer registered in the location of the Project. Provide roof supports by Trikon Systems, MIRO Industries (Unistrut), Advanced Support Products Inc., or Portable Pipe Hangers Inc.
- 2.1.7. All hangers, supports, brackets and other devices installed exterior to the building shall be galvanized to prevent failure from environmental corrosion. If galvanized components cannot be used submit samples of proposed substitute for review prior to installation.
- 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 Engineer's Representative. 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 Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- 3.1.6. For precast concrete construction, hanger rods shall pass between slabs and be supported on the slab within the topping by a 100 mm x 100 mm x 3 mm (4 in. x 4 in. x 1/8 in.) steel plate welded to the hanger rod. A lock nut threaded to the hanger rod together with a 50 mm (2 in.) minimum dia. washer shall be applied tight against the under surface of the deck to prevent rising of the hanger.
- 3.1.7. Approved type expansion shields and bolts may be used for pipe up to 100 mm (4 in.) diameter where the presetting of concrete inserts is not practical. Submit proposed hanger details for review and acceptance by the Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- 3.1.8. Suspension from metal deck shall not be allowed unless specifically accepted by the Engineer's Representative. Drawings of the proposed method of suspension must be submitted for review.
- 3.1.9. Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CSA S413 "Parking Structures" and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.
- 3.1.10. 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		
50 mm (2 in.) and under	9 mm (3/8 in.)		
65 mm (2-1/2 in.) and 75 mm (3 in.)	12 mm (1/2 in.)		
100 mm (4 in.) and 125 mm (5 in.)	16 mm (5/8 in.)		
150 mm (6 in.) to 200 mm (8 in.)	19 mm (3/4 in.)		
250 mm (8 in.) to 300 mm (12 in.)	22 mm (7/8 in.)		

3.1.11.Unless otherwise specified or shown, hanger spacing for all services shall be as follows:
Nominal Pipe DiameterMaximum Span

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	Up to and including 38 mm (1-1/2 in.)	2.1 m (7 ft.)		
	50 mm (2 in.) to 125 mm (5 in.)	3 m (10 ft.)		
	150 mm (6 in.) and larger	4.6 m (15 ft.)		
3.1.12.	In addition, provide a hanger within 600 m pipes 38 mm (1½ in.) diameter and larger.	m (2 ft.) on each side of valves, fitting or tees on		
3.1.13.	Hanger spacing for plumbing and drainage code or municipal by-laws as applicable.	e services shall be in accordance with the plumbing		
3.1.14.	Hanger spacing for fire protection services	shall be in accordance with the NFPA codes.		
3.1.15.	All horizontal piping 50 mm (2 in.) diamete wrought iron clevis type hangers. Smaller hangers or clevis type hangers.	er and larger shall be supported by adjustable piping shall be supported by adjustable split ring		
3.1.16.	Suspending one hanger from another sha	I not be permitted.		
3.1.17.	5.1.17. For all domestic hot water piping, 50 mm (2 in.) and larger, use a standard catalogue protection saddle tack welded to the pipe, which provides a space between the pipe and hanger equal to the thickness of the insulation.			
3.1.18.	For all domestic hot water piping, 38 mm (1-1/2 in.) and smaller, use line size hangers.		
3.1.19.	3.1.19. For all domestic cold water piping, 25 mm (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 20 07 00.00 - INSULATION.			
3.1.20.	For all domestic cold water piping, , larger between the insulation and the hanger. Be high density insulation complete with conti 00.00 - INSULATION.	than 25 mm (1 in.), use a galvanized steel shield etween the shield and the pipe, install a section of nuous vapour barrier. Refer to Section 20 07		
3.1.21.	The shield width shall be minimum 1/4 of t be as follows:	he pipe circumference. The length and gauge shall		
	.1 150 mm (6 in.) long and 14 US gau in.) diameter	ge for pipe larger than 25 mm (1in.) up to 50 mm (2		
	.2 250 mm (10 in.) long and 12 US ga diameter	uge for pipes 65 mm (2-1/2 in.) to 300 mm (12 in.)		
	.3 300 mm (12 in.) long and 10 US ga diameter	uge for pipes 350 mm (14 in.) to 400 mm (16 in.)		
3.1.22.	Hangers and riser clamps in contact with on plastic coated. Taped hangers and riser cl	copper pipe shall be copper coated construction or amps shall not be accepted.		
3.1.23.	Unless otherwise specified or shown, all pipes supported from below shall be mounted on pip rolls or pipe slides.			
3.1.24.	Unless otherwise specified or shown, vertical pipes shall be supported at least every fourth floor or every 12 m (40 ft.) maximum.			
3.1.25.	Pipe slides shall be pre-engineered type. Structural or fabricated tees shall be welded to the pipe or to the protection saddle.			
3.1.26.	Install resilient hangers in accordance with CONTROL.	Section 20 05 48.00 - VIBRATION AND NOISE		
3.1.27.	Other means of support shall be as showr	or as specified hereunder.		

20 05 48.00 Vibration and Noise Control

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 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 in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Provide Shop Drawings showing completely the various acoustic assemblies. Include on the Shop Drawings the equipment weight at each isolator and the isolator proposed to be used complete with its weight rating. Submit Shop Drawings after all major equipment (e.g. chillers, cooling towers, etc.) has been reviewed and isolators have been coordinated.

1.3. PERFORMANCE REQUIREMENTS

1.3.1. Adequately isolate all equipment to maintain acceptable noise levels in the occupied area of the building as specified below. Take noise measurements over the complete audible frequency range in each of the occupied zones under, above and beside Mechanical Equipment Rooms, and where indicated by the Engineer's Representative. Noise levels due to mechanical equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall not exceed sound pressure levels in all 8 octave bands corresponding to the NC levels per ASHRAE handbook as indicated.

1.3.2.	AREAS	NC LEVELS
	General offices	35 NC
	Meeting Rooms	35 NC
	Corridor and Lobbies	35 NC
	Storage Rooms	40 NC
	Entrance Halls	40 NC
	Outdoors	45 dBA

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, VMC Amber Booth, or Mason Industries and shall be one manufacturer throughout the Project.
- 2.1.3. Provide vibration isolation devices for all motorized or electrical equipment. Static deflection of isolators shall be as given in the Vibration Isolation Schedule and/or as specified below. The Vibration Isolation Schedule shall take precedence.

2.2. VIBRATION ISOLATION

- 2.2.1. Type EP (Elastomeric Pad) Vibro-Acoustics Model N, Kinetics Model NPD, Mason Industries Model W or Super W, or ISOTECH Model IR or ISOPAD.
 - .1 Type EP shall be 8 mm thick ribbed or waffle neoprene pads. Isolator pads shall be selected for less than 80% maximum rated load.
 - .2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- 2.2.2. Type MEP (Metal and Elastomeric Sandwich Pad) Vibro-Acoustics Model NSN, Kinetics Model RSP, Mason Industries Model WSW, or ISOTECH Model IRMR or IPMP.
 - .1 Type MEP shall consist of two 8 mm thick ribbed or waffle neoprene pads bonded to each side of a 16-gauge stainless or galvanized steel shim plate. Isolator pads shall be selected for less than 80% maximum rated load.
 - .2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved shall be installed under the bolt head between the steel washer and the base plate.
- 2.2.3. Type DDNM (Double Deflection Neoprene Mounts) Vibro-Acoustics Model RDM, Kinetics Model RD, Mason Industries Model ND, or ISOTECH Model IDR.
 - .1 Type DDNM shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
 - .2 DDNM mounts shall be selected for a static deflection of 9.5 mm unless specified otherwise.
- 2.2.4. Type DDNH (Double Deflection Neoprene Hangers) Vibro-Acoustics Model RHD, Kinetics Model RH, Mason Industries Model HD, or ISOTECH Model IHND.
 - .1 Type DDNH shall consist of a molded neoprene isolating element in a steel hanger box. 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. The diameter of the clear hole in the hanger box shall be at least 19 mm larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed the hanger box shall be allowed to rotate through a full 360 degrees without encountering an obstruction.
 - .2 Unless otherwise specified the static deflection of DDNH hangers shall be 8 mm.
- 2.2.5. Type SPNM (Spring and Neoprene Mounts) Vibro-Acoustics Model FS, Kinetics Model FDS, Mason Industries Model SLFSW, or ISOTECH Model IOSB.
 - .1 Type SPNM shall have a free standing and laterally stable steel spring without any housing, and two type WP isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bonded to the isolator base plate. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
 - .2 Unless otherwise specified the minimum static deflection of SPNM isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted elsewhere.

- .3 Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- 2.2.6. Type SPH (Spring Hangers) Vibro-Acoustics Model SH, Kinetics Model SH, Mason Industries Model 30, or ISOTECH Model IHS, IHA or IHB.
 - .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.).
- 2.2.7. Type SPNH (Spring and Neoprene Hangers) Vibro-Acoustics Model SHR, Kinetics Model SRH, Mason Industries Model 30N, or ISOTECH Model IHSE, IHAE or IHBE.
 - .1 Type SPNH 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 Type SPNH shall include the addition of a neoprene element in series with the spring. The neoprene element shall have a deflection of not less than 9 mm with a strain not exceeding 15%. Unless otherwise specified, the static deflection of SPNH hangers under actual load conditions shall be 50 mm (2 in.).
- 2.2.8. 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.
- 2.2.9. 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.
- 2.2.10. 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.
- 2.2.11. 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.
- 2.2.12. All mounts installed outdoors or exposed to high humidity conditions shall have two coats of rust resisting paint and springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized.
- 2.2.13. Neoprene mounting sleeves for hold down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.

- 2.2.14. Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses.
- 2.2.15. Acoustic Sealant: Non-hardening, non-skinning permanently flexible, to CAN/CGSB-19.21 "Sealing and Bedding Compound, Acoustical." Tremco, CGC Acoustic Sealant or approved equivalent.
- 2.3. INTERNAL ACOUSTIC DUCT INSULATION
- 2.3.1. Fiberglass duct liner shall be manufactured by Certainteed, Owens-Corning, Knauf Insulation, or Johns Manville.
- 2.3.2. Natural fibre duct liner shall be manufactured by Bonded Logic.
- 2.3.3. Acoustic duct insulation shall have a minimum density of 24 kg/m3 (1.5 lbs/ft3).
- 2.3.4. Acoustic duct insulation shall comply with the requirements of NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilation Systems" and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturer's Association.
- 2.3.5. Duct sizes shown on the Drawing are free area dimensions (after the installation of internal acoustic duct insulation). Internal acoustic duct insulation shall be a minimum of 25 mm (1 in.) unless shown otherwise.
- 2.3.6. All internal acoustic duct insulation shall incorporate means to prevent fiber entrainment in the air stream.
- 2.3.7. The following ductwork shall be internally insulated:
 - .1 All return air transfer ductwork.
 - .2 All ductwork specifically identified in Specifications and/or on the Drawings.
 - .3 All supply and return air ductwork in the amenities, lobbies and common areas that serve that space.
- 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. On system start-up, inspect the complete installation and provide a report in writing.
- 3.1.3. Furnish concrete bases, including concrete fill, on springs or other vibration isolation materials for mechanical isolation.
- 3.1.4. All floor mounted equipment shall be erected on concrete housekeeping pads, with thickness as identified, over the complete floor area of the equipment, unless shown or specified otherwise. Wherever vibration eliminating devices and/or concrete inertia pads are specified, these items shall be mounted on concrete housekeeping pads.
- 3.1.5. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.
- 3.1.6. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 6 mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.

- 3.1.7. Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 50 mm (2 in.) between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short-circuit the vibration isolators. There shall be a minimum 100 mm (4 in.) clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
- 3.1.8. Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.
- 3.1.9. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping, and blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.
- 3.1.10. All mechanical equipment not specifically identified in this Section that contains rotating or vibrating elements, and any associated electrical apparatus installed by this Division that contains transformers or inductors shall be installed on Type DDNM, MEP, or EP isolators as appropriate.
- 3.1.11. All wiring connections to mechanical equipment on isolators shall be made with a flexible conduit installed in a slack "U" shape.
- 3.1.12. Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.
- 3.1.13. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
- 3.1.14. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
- 3.1.15. Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.
- 3.1.16. All fan bases and isolators shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

3.2. EQUIPMENT ISOLATION

- 3.2.1. Suspend all piping in Mechanical Rooms on Type SPH or SPNH isolators as required. Where piping is supported from the floor, weld brackets to the piping and support on Type SPNM isolators. Isolators do not replace constant support hangers or mounts.
- 3.2.2. 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.
- 3.2.3. Where a pipe connects to multiple pieces of equipment in the Mechanical Room the pipe isolators for the entire run shall be chosen to suit the connected equipment of the greatest static deflection.
- 3.2.4. Piping that is connected only to equipment installed on neoprene isolators shall be either supported from the floor by Type DDNM isolators or suspended from the structure on Type DDNH isolators within the Mechanical Equipment Rooms.
- 3.2.5. Install double sphere EPDM type flexible piping connectors with: control rods with grommets to limit vibration transfer; stabilizing ring; and floating flanges, to connect piping of diameter 50 mm (2 in.) or greater to reciprocating or rotating equipment.

- 3.2.6. Piping attached to either coil sections separated from the fan sections of air handling units by flexible connections, or to air handling units with internal isolators meeting the requirements of these Specifications is exempt from these requirements and is not considered connected to vibrating equipment.
- 3.2.7. No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.
- 3.2.8. Any conflicts with other trades which result in rigid contact with the equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Engineer's Representative's attention prior to installation. If not brought to the attention of the Engineer's Representative prior to installation corrective Work necessitated by conflicts shall be at the Contractor's expense.
- 3.2.9. 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.

20 05 53.00 Pipe and Ductwork Identification

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. RELATED WORK SPECIFIED ELSEWHERE
- 1.2.1. Field painting of non-colour coded piping and ductwork under Division 9, Section 09 90 00.00 PAINTING AND COATING.
- 1.3. SUBMITTALS
- 1.3.1. Submit designations and abbreviations for review in accordance with Section 20 05 03.00 SHOP DRAWINGS. Submit digital samples of identification for review.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. Paint shall be compatible with the surface material to be painted.
- 2.1.2. Colour code shall conform to CAN/CGSB 24.3-92 "Identification of Piping Systems" and ANSI/ASME A13.1 "Scheme For The Identification Of Piping Systems."
- 2.1.3. Pipe covering shall be SMS, Brady, Primark Manufacturing Inc. and Seton equal to SMS Coil-Mark system pipe markers.
- 2.1.4. All identification shall incorporate direction of flow arrows, and the specified system designations and abbreviations. Designations and abbreviations shall be submitted for review prior to installation.
- 2.1.5. All reclaimed rainwater distribution systems shall be purple in colour and conform to requirements of NSF-RW and NSF/ANSI Standard 14 "Plastics Piping System Components and Related Materials." All other non-potable water piping shall conform to the requirements of CAN/CSA B128.1 "Design and Installation of Non-potable Water Systems," CAN/CSA B128.2 "Maintenance and Field Testing of Non-potable Water Systems," and CAN/CSA B128.3 "Performance of Non-Potable Water Treatment Systems."
- 2.1.6. Colour code shall conform to the requirements under the by-laws of the Authority Having Jurisdiction.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. After completion of insulation and/or painting, all piping and ductwork shall be marked to show the service and direction of flow.

- 3.1.2. Marking shall be placed at each side of any wall, partition or floor, at 9.1 m (30 ft.) intervals (maximum) on all exposed piping and ductwork and at each access panel or door. Marking shall be located so as to be in full view and visible from the floor.
- 3.1.3. All pipe identification shall be installed in accordance with the manufacturer's recommendations.
- 3.1.4. Pipe identification markers for insulated or non-insulated pipe sizes less than 150 mm (6 in.) circumference shall be pre-coiled and shall cover the pipe in its entirety and be joined using adhesive along the longitudinal joint. In addition to the adhesive the marking system shall be banded with clear plastic tie-wraps on each end.
- 3.1.5. Pipe identification markers for insulated or non-insulated pipe sizes equal to and greater than 150 mm (6 in.) circumference shall be strapped on with recommended tie-wraps.
- 3.1.6. Adhesive labels are not acceptable.
- 3.1.7. Gas piping shall be painted yellow for the entire length and identified with pipe identification markers. Banding is not permitted.
- 3.1.8. All electric traced piping shall have additional identification to show it is traced.
- 3.1.9. Identify ductwork with 50 mm (2 in.) stencils using black or white ink to contrast the surface being identified.
- 3.1.10. Identification location for ductwork shall conform to the guidelines for pipe and shall indicate flow medium, function, and direction.
- 3.1.11. Contractor shall ensure stenciling is performed in a neat, quality manner.

20 05 54.00 Nameplates

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Nameplates for systems include the designated equipment name, model number and main design parameters.
- 1.1.3. Every piece of equipment shall have a nameplate.
- 1.2. SUBMITTALS
- 1.2.1. Submit samples of nameplates before installation in accordance with Section 20 05 03.00 SHOP DRAWINGS.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. The nameplates must be a minimum 2 mm (3/32 in.) thick micro surface impact acrylic suitable for a service temperature up to -29 Deg. C. through 80 Deg. C. (-20 Deb. F. through 175 Deg. F.). Minimum size shall be 100 mm (4 in.) long x 50 mm (2 in.) wide with maximum size to suit nomenclature required. Nameplate shall be with black face and white centre and with 5 mm (7/32 in.) high lettering engraved through to the white lamination.
- 2.1.2. The nameplates shall have the equipment type and name as indicated in the Equipment Schedules.
- 2.1.3. The nameplates shall have the service and area of the building served (e.g. Chilled Water South Zone).
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Nameplates shall be securely fastened with screws or brass chains in a conspicuous place on the equipment.

20 05 55.00 Valve Tags and Charts

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Submit samples of charts and numbering system before installation in accordance with Section 20 05 03.00 SHOP DRAWINGS.
- 2. Products

2.1. MATERIALS

- 2.1.1. Tags must be a minimum 2 mm (3/32 in.) thick Micro Surface Impact Acrylic suitable for a service temperature up of -29°C through 80°C (-20°F through 175°F), with engraved numbers and/or letters as required. Tags shall be a minimum of 25 mm (1 in.) square and maximum to suit numbering system. Numbers shall be nominally 9 mm (3/8 in.) high. Letters shall be nominally 6 mm (1/4 in.) high.
- 2.1.2. Number and nameplates for standpipe and sprinkler system supervisory and main operating valves shall be minimum 2 mm (3/32 in.) thick laminated phenolic plastic and a minimum 125 mm (5 in.) long x 100 mm (4 in.) wide with red face and white centre. Lettering shall be a minimum 9 mm (3/8 in.) high with maximum to suit local authorities and shall be engraved through to the white lamination. Each nameplate shall contain the system name, service and valve number.
- 2.1.3. For all other valves on standpipe and sprinkler system not required to have laminated number and nameplates, provide plastic tags as specified above.
- 2.1.4. Abbreviations and colour code shall be as shown on Standard Details.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Tags and nameplates shall be attached to the valve body or handle with brass hooks or chains.
- 3.1.2. All valves shall be provided with tags, other than valves on convectors, induction units or other space heating, cooling units and valves on plumbing fixtures. Provide a chart or charts, indicating location, service and zone of each valve. This Work shall be co-ordinated between the various Mechanical Sections to prevent overlapping of numbering systems.
- 3.1.3. Provide separate charts for all fire system nameplates and tags.
- 3.1.4. For extension and/or alterations to existing systems, provide new charts conforming in appearance to the existing charts.
- 3.1.5. Co-ordinate valve identification with pipe and ductwork identification.

- 3.1.6. Roof drains used for restricting or controlling the flow of water from the roof or acting as an overflow shall be affixed with an identification label "Control Flow Roof Drain Do Not Remove Restriction Device".
- 3.1.7. Electronically submit charts as PDF files along with as-built drawings. Provide charts set in metal picture frames with a clear acrylic front and fastened securely where directed by Engineer's Representative.
- 3.1.8. All valve tag numbers for all systems shall be shown on the as-built drawings.

20 07 00.00 Insulation

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Provide Shop Drawings with technical data on all types of insulation to be installed, in accordance with Section 20 05 03.00 SHOP DRAWINGS.
- 1.2.2. Provide two samples of each type of insulation indicating where each is to be used, and a sample of a typical vapour barrier dam, where vapour barrier dams are called for: in Part 3 or on the Drawings. Samples shall be mounted on boards. One shall be kept at the Contractor's site office and the other shall be turned over to the Engineer's Representative.
- 2. Products
- 2.1. GENERAL
- 2.1.1. Provide insulation and jacket systems that are fire retardant, with a flame-spread rating not to exceed 25 and a smoke developed classification not to exceed 50, when tested in accordance with CAN/ULC S102 "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies."
- 2.1.2. For indoor applications, provide insulation systems (insulation, jackets, adhesives, coatings, etc.) that are Certified under the UL GREENGUARD Certification Program for low chemical and particle (volatile organic compounds (VOC)) emissions.
- 2.2. PIPE INSULATION
- 2.2.1. Type P1 Inorganic mineral fibre: glass wool, rock wool, slag wool.
 - .1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."
 - .2 Rigid, pre-formed, with pressure sensitive longitudinal adhesion strip.
 - .3 Reinforced all service jacket (ASJ) vapour retarder.
 - .4 Suitable for temperature range of pipe application in question.
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Manson
 - .4 Owens-Corning
 - .5 Or approved alternate.

2.3. DUCT INSULATION

- 2.3.1. Type D2 Inorganic mineral fibre board:
 - .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
 - .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Suitable for temperature range of duct application in question.
 - .4 Density: 48 kg/cu.m. (3 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Owens-Corning
 - .4 Rockwool
 - .5 Or approved alternate.

2.4. JACKETS

- 2.4.1. All service jacket (ASJ)
 - .1 As indicated in insulation types above.
- 2.4.2. Foil skim kraft (FSK)
 - .1 As indicated in insulation types above.
- 2.4.3. Insulation Jacketing System:
 - .1 Multi-layered, reinforced laminate jacketing tape with acrylic pressure sensitive adhesive.
 - .2 Zero permeability; self-adhesive; UV and weather resistant.
 - .3 Colour: Natural aluminum or white, as chosen at Shop Drawing stage.
 - .4 Finish: flat or embossed, as chosen at Shop Drawing stage.
 - .5 Acceptable manufacturers:
 - .1 3M VentureClad Insulation Jacketing System 1577 Series
 - .2 3M VentureClad Heavy Duty Jacketing System 1579 Series
 - .3 Or approved alternate.
- 2.4.4. Polyvinyl Chloride (PVC) jacket:
 - .1 Pre-moulded PVC covers.
 - .2 Pre-moulded PVC elbows and fittings.
 - .3 Minimum thickness: 20 mil.
 - .4 Colour: white or coloured as chosen at Shop Drawing stage.
 - .5 Tape: vinyl, pressure sensitive, colour matched.
 - .6 Sealed with adhesive.
- 2.5. SECUREMENT
- 2.5.1. Banding
 - .1 Aluminum or Stainless steel.

- 2.5.2. Tie Wire
 - .1 Stainless steel.
 - .2 Minimum 1.3 mm (16 gauge).
 - .3 Twisted ends.
- 2.5.3. Corner beads and channels at floor line:
 - .1 Minimum 0.4 mm (28 gauge) galvanized sheet metal.
- 2.5.4. As per insulation / jacket manufacturer's written installation instructions.

2.6. CEMENTS AND ADHESIVES

- 2.6.1. Where cements or adhesives are required, provide those that are compatible with insulation and jacket, per insulation and jacket manufacturer's written recommendations / instructions.
- 2.6.2. Vapour barrier dam:
 - .1 CHIL-PERM CP-30 with fibreglass cloth reinforcing.
- 3. Execution

3.1. INSTALLATION

- 3.1.1. Install insulation in accordance with the manufacturer's written 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 "Energy Standard for Buildings except Low-rise Residential Buildings" and in National Energy Code of Canada for Buildings (NECB), (refer to Table 2 below), 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. Do not commence insulation installation until testing report is submitted to Engineer's Representative and is reviewed by Engineer's Representative without requesting a resubmit.
- 3.1.5. Where pipes and ducts are specified to be insulated, insulate complete piping system and duct system with no gaps in insulation.
- 3.1.6. Protect insulation and pipe from moisture ingress where insulation is installed exterior to the building.
- 3.1.7. Utilize oversized hangers and pipe supports where pipes are installed exterior to the building and are to be insulated. Hangers and supports to support assembly on the outside of the insulation, so as to protect insulation and pipe from water damage due to ambient conditions.
- 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 26.7 deg. C. (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. Where tie wires are used, install on maximum 305 mm (12 in.) centres.
- 3.1.14. Install insulation jackets with minimum 50 mm (2 in.) laps.
- 3.1.15. Provide insulation and jacket systems in accordance with Table 1 below:

TABLE 1: INSULATION AND JACKET SYSTEMS

Pipe Application	Insulation	Thickness	Jacket
Domestic hot water piping	Type P1	Per Table 2	Per insulation type
Domestic cold water piping	Type P1	38 mm (1-1/2 in.)	Per insulation type
Duct Application	Insulation	Thickness	Jacket
Roof top Unit Curbs	Type D2	25 mm (1 in.)	Per insulation type

20 08 00.00 Commissioning

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Conform to Section 20 05 02.00 AS-BUILT DRAWINGS.
- 1.1.3. Conform to Section 20 05 03.00 SHOP DRAWINGS.
- 1.1.4. Conform to Section 20 08 03.00 OPERATING AND MAINTENANCE INSTRUCTIONS.
- 1.1.5. Conform to Section 23 05 93.13 TESTING AND BALANCING PIPING SYSTEMS.
- 1.1.6. Conform to Section 23 05 93.23 TESTING AND BALANCING AIR SYSTEMS.
- 1.1.7. Conform to Section 23 09 00.00 BUILDING AUTOMATION SYSTEM (BAS).
- 1.1.8. The commissioning process for the Mechanical Systems shall include:
 - .1 Verification that the installation meets the requirements of the Contract Documents.
 - .2 Verification that the system's performance meets the design intent.
 - .3 Provision of building operator training.
 - .4 Provision of as-built documentation, operating and maintenance manuals, and systems operating manuals.
- 1.1.9. The Contractor and Engineer's Representative provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.
- 1.1.10. Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- 1.1.11. An Independent Testing and Balancing Contractor will provide the services identified in the Sections for "Testing and Balancing Piping and Air Systems".
- 1.2. SUBMITTALS
- 1.2.1. Submittals requested in this Section shall be submitted in accordance with Section 20 05 03.00 SHOP DRAWINGS.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Mechanical Sections. The Contractor shall advise the Engineer's Representatives of instrumentation to be used and the dates the instruments were calibrated.

3. Execution

3.1. INSTALLATION

- 3.1.1. This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.
- 3.1.2. The commissioning process shall consist of:
 - .1 Shop Drawings/as-built drawings
 - .2 Installation review and equipment verification
 - .3 Plumbing and drainage system testing
 - .4 Testing of piping systems
 - .5 Independent Contractor balancing of piping systems
 - .6 Testing of air systems
 - .7 Independent Contractor balancing of air systems
 - .8 Testing of equipment and systems
 - .9 Building Automation System Commissioning
 - .10 Commissioning meetings
 - .11 Operating and maintenance manuals
 - .12 Training
 - .13 Systems acceptance

3.2. INSTALLATION REVIEW AND EQUIPMENT VERIFICATION

3.2.1. The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Engineer's Representative for review and be included in the operating and maintenance manuals.

3.3. TEST FORMS AND VERIFICATION FORMS

- 3.3.1. The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Engineer's Representative for review on a monthly basis.
- 3.3.2. The forms shall be signed by either the Authorities Having Jurisdiction, the Engineer's Representative where applicable.
- 3.3.3. Test forms and verification forms have been included with this Section. Obtain approval from the Engineer's Representative if the Contractor wishes to use different forms.
- 3.4. PLUMBING AND DRAINAGE SYSTEM TESTING
- 3.4.1. The Contractor shall notify the Building Inspector when systems are available for testing. The Contractor shall document all tests performed and shall arrange for the Building Inspector to sign the forms for tests completed.
- 3.5. TESTING OF AIR SYSTEMS
- 3.5.1. Conform to Section 23 05 93.23 TESTING AND BALANCING AIR SYSTEMS.
- 3.5.2. All tests shall be performed in the presence of the Engineer's Representative.

3.6. TESTING OF EQUIPMENT AND SYSTEMS

- 3.6.1. Conform to Section 20 08 03.00 OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.6.2. The Contractor shall hire the services of the manufacturer's technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Engineer's Representative. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- 3.6.3. Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Engineer's Representative.
- 3.6.4. Tests which have not been witnessed shall not be accepted and shall be repeated.

3.7. COMMISSIONING MEETINGS AND SCHEDULING

- 3.7.1. The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- 3.7.2. The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.

3.8. OPERATING AND MAINTENANCE MANUALS

- 3.8.1. Conform to Section 20 08 03.00 OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.8.2. Submit Operating and Maintenance Manuals to Engineer for review.

3.9. OPERATOR TRAINING

- 3.9.1. Conform to Section 20 08 03.00 OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.9.2. Submit Operating and Maintenance manuals to Engineer for review.
- 3.9.3. The training shall be conducted at the equipment or system.
- 3.9.4. Training will begin when the operating and maintenance manuals have been delivered to the Owner and reviewed by the Engineer's Representative.
- 3.9.5. Submit a course outline to the Engineer's Representative before training commences. Provide course documentation for up to eight people.
- 3.9.6. Each training session will be structured to cover:
 - .1 The operating and maintenance manual
 - .2 Operating procedures
 - .3 Maintenance procedures
 - .4 Trouble-shooting procedures
 - .5 Spare parts required
- 3.9.7. Training shall be provided for the following systems:

System Minimum Training Times

Rooftop Units4 hoursBAS Controls SystemConform to 23 09 00.00

3.9.8. Refer to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEMS (BAS).

3.9.9. The training requirement for the mechanical system shall include a walk-through of the building by the Contractor. During the walk through the Contractor shall:

- .1 Identify equipment
- .2 Identify starters associated with equipment
- .3 Identify valves and balancing dampers
- .4 Identify access doors
- .5 Review general maintenance of equipment
- .6 Review drain locations in pipework systems
- .7 Identify maintenance items

3.10. PERFORMANCE TESTING

- 3.10.1. The Contractor shall conduct performance tests on all mechanical systems and document the results on the performance forms. Request form from the Engineer's Representative.
- 3.10.2. Performance testing will begin when all mechanical systems have been completed, tested by the Contractor, reviewed by the Engineer's Representative and Substantial Completion has been achieved.

3.11. COMMISSIONING PROCESS ALLOCATION

- 3.11.1. The commissioning process shall be allocated a % of the contract value equal to the total of the allocationed noted below. This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of Work. The Contractors may draw from this allocation as the commissioning process is completed.
 - .1 The Contractors shall submit all test and verification forms. The Engineer's Representative will use these forms to calculate a percentage complete.
 - .2 The Contractor may claim up to 5% of the contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.
- 3.11.2. The commissioning process allocation shall be broken down as follows:

Shop Drawings	0.50%
Installation review and equipment verification	0.50%
Plumbing and drainage system testing	0.50%
Testing of piping systems	0.50%
Testing of air systems	0.50%
Independent Contractor balancing of air systems	0.25%
Testing of equipment and systems (system start-up)	0.50%
BAS commissioning	1.00%
Operating and Maintenance Manuals	0.50%
Training	0.50%
As-built drawings	0.50%

20 08 02.00 Cleaning and Protection

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 2. Products
- 2.1. NOT USED
- 3. Execution

3.1. INSTALLATION

- 3.1.1. Clean thoroughly all fixtures and equipment from grease, dirt, plaster or any other foreign material. Chrome-plated fittings, piping and trim shall be polished upon completion.
- 3.1.2. Fixtures and equipment shall be properly protected from damage during the construction period and shall be cleaned and polished in accordance with manufacturer's written directions. Motors and equipment bearings shall be protected with plastic sheets, tied or taped in place. Aluminum fin heating or cooling elements shall be protected with cardboard covers.
- 3.1.3. Any dirt, rubbish, or grease on walls, floors or fixtures accumulated from the Work of the Mechanical Division shall be removed promptly from the premises by this Division.
- 3.1.4. Any unpainted steel surfaces, installed for longer than one year prior to the completion date, shall be prime coated under this Division.
- 3.1.5. During construction protect all services and equipment from dirt and debris, by using temporary caps over the open ends of pipes ductwork and equipment connections.
- 3.1.6. All equipment installed or stored on site shall be maintained in accordance with manufacturer's recommended instructions (i.e. rotate shafts on fans, pumps, etc).
- 3.1.7. Refinish and restore to the original condition and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and work quality shall be equal to the manufacturer's original.

20 08 03.00 Operating and Maintenance Instructions

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Comply with all requirements of Section 20 05 02.00 AS-BUILT DRAWINGS.
- 1.1.3. Comply with all requirements of Section 20 05 03.00 SHOP DRAWINGS.
- 1.1.4. Comply with all requirements of Section 20 08 00.00 COMMISSIONING.
- 1.1.5. Comply with all requirements of Section 01 78 00 CLOSEOUT SUBMITTALS.
- 2. Products

2.1. REQUIREMENTS FOR MANUALS

- 2.1.1. Three copies of complete and approved operating and maintenance instructions for all mechanical equipment and systems shall be supplied before Substantial Completion. Manuals shall be also submitted in electronic format. Electronic manuals shall be prepared in Adobe PDF format with all sections bookmarked for quick reference and submitted on a portable data storage device.
- 2.1.2. Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "(Project Name)".
- 2.1.3. Terminology used in all the Sections shall be consistent.
- 2.1.4. Volume One shall contain the master index of all systems, the name of the Contractor, Mechanical Subcontractors and the date of Substantial Performance of the Work.
- 2.1.5. Volume One shall contain a section with all necessary warranty information.
- 2.1.6. Each binder shall have a complete index for all volumes.
- 2.1.7. Each binder shall be no more than half filled.
- 2.1.8. There shall be a separate section for all materials used on the Project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.
- 2.1.9. There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- 2.1.10. All relevant information relating to a system or Product shall be contained within one binder.
- 2.1.11. The manual sections shall follow the Specification sections.
- 2.1.12. Any diagrams, installation drawings, flow charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.
- 2.2. DATA FOR MANUALS
- 2.2.1. Equipment data shall contain:
 - .1 Operating instructions

- .2 Operating conditions such as temperature and pressure
- .3 Location of equipment
- .4 Maintenance instructions and schedules for one year routine
- .5 Recommended list of spare parts
- .6 Lubrication schedule
- .7 A trouble shooting table showing where to look for problems under various conditions of malfunction
- .8 All wiring diagrams
- .9 Equipment operating curves
- .10 Equipment nameplate data and serial numbers
- 2.2.2. System data shall contain:
 - .1 A listing of all systems
 - .2 A valve schedule and locations
 - .3 Equipment name tags
 - .4 Filter schedule
 - .5 An electric pipe tracing schedule including location and electrical service location
 - .6 Cleaning, maintaining and preserving instructions for all material, Products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.
- 2.2.3. Subcontractor manuals are required for:
 - .1 BAS
 - .2 Water treatment
 - .3 Sprinkler system
 - .4 Piping and air balancing
- 2.2.4. As-built documentation shall contain:
 - .1 Reviewed As-built Shop Drawings
 - .2 As-built construction drawings
 - .3 Originals of test forms
 - .4 Originals of test certificates

2.3. OPERATING INSTRUCTIONS

- 2.3.1. Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.
- 2.3.2. Comply with all requirements of Section 20 08 00.00 COMMISSIONING, for duration of tests.
- 2.3.3. Instruct the Owner for a minimum of five (5) Working Days.
- 2.3.4. Arrange for and pay for the services of engineers and other manufacturer's representatives required for instruction on the systems and the equipment as requested by the Engineer's Representative and/or the Owner.

- 2.3.5. At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Engineer's Representative, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- 2.3.6. Review information with the Owner's representative to ensure that all information required has been provided.
- 2.3.7. Mechanical equipment and systems included in the instruction requirements are:
 - .1 Chillers and associated equipment
 - .2 Heating water generators and associated equipment
 - .3 Automatic controls and instrumentation
 - .4 Water treatment and cleaning
 - .5 Life safety and fire protection
 - .6 Noise and vibration
 - .7 Condenser water distribution system
 - .8 Chilled water distribution systems
 - .9 Heating water distribution systems
 - .10 Air handling distribution and components
 - .11 Miscellaneous ventilation systems
 - .12 Humidification systems
 - .13 Storm, sanitary and domestic water pumping and distribution system

2.4. TRIAL USAGE

- 2.4.1. The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any injury or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or work quality of any kind.
- 3. Execution
- 3.1. NOT USED

22 11 13.00 Pipes, Valves and Fittings (Plumbing System)

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 SHOP DRAWINGS.
- 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 valves on potable water systems shall be equal in performance to the models specified, shall be lead free or low lead meeting the requirements of CSA B125.3 "Plumbing fittings," CSA B125.14 "Manually operated valves for use in plumbing systems," NSF/ANSI 372 "Drinking Water System Components Lead Content," NSF/ANSI 61 "Drinking Water System Components Health Effects," NSF/ANSI 14 "Plastics Piping System Components and Related Materials," and/or ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" as applicable.
- 2.1.3. All city and domestic water, above ground, 75 mm (3 in.) and smaller, less than 1380 kPa (200 psi) working pressure:
 - .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings" or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 "Cast Copper Alloy Solder Joint Pressure Fittings."
 - .2 Joints made with 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, ASTM B32 "Standard Specification for Solder Metal."
 - .3 Grooved end copper fittings designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper or bronze casting, conforming to ASTM B75/B75M "Standard Specification for Seamless Copper Tube." Victaulic Copper Connection Fittings.
 - .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 P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F.). Victaulic 607.
 - .5 Stainless steel pipe may be used as an alternative material if acceptable to Local Authorities. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes." Stainless steel fittings to conform to

ASTM A403 "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings."

- .6 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi) with cast brass bronze body, aluminum-bronze disc, pressure-responsive grade P fluoroelastomer seat, and stainless steel stem. Victaulic 608N.
- .7 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, rising stem screwed. Kitz 827/828, Toyo 206A-LF/207A-LF, Apollo 101T-LF.
- .8 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, solder ends or with screwed to solder adapter and composition disc for water service. Kitz 811/812, Toyo 211A-LF/212A-LF, Apollo 120S-LF.
- .9 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, swing check, solder ends. Kitz 822/823, Toyo 236A-LF/237A-LF, Apollo 161S-LF.
- .10 Non-slam check valves downstream from pumps, ANSI Class 150, 1032 kPa (150 psi) WSP pressure rating, dual flapper design with 316 stainless steel body and stainless steel check, renewable disc and resilient seat for flanged installation. Non-slam check valves shall be Velan-ProQuip Model DDD11-1D, Duo CHEK II H15CMF3-14, Mueller 72-HHH-3-H, or NCI/SSI 150WTTTV-T.
- .11 Strainers shall be lead free bronze Y body equal to Colton Industries Model 125YTB, Mueller LF351.
- .12 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with lead free, bronze body or forged brass body, solid ball, male threaded garden hose end, brass cap and chain equal to Watts B6000, Toyo 5046-LF, Kitz 868C or Apollo 78-100. Hose bibs shall be for 860 kPa (125 psi) non-shock, bronze body with composition disc and 19 mm (3/4 in.) garden hose thread, complete with a ULC vacuum breaker.
- .13 Pipe sizes 12 mm (1/2 in.) to 50 mm (2 in.) Schedule 10 Type 304/304L to ASTM A312/A312M "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes."
 - .1 Vic-Press 304 ASTM A312 stainless steel housings with ASTM A276 "Standard Specification for Stainless Steel Bars and Shapes" and A312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade "H" (HNBR) seals rated for applicable services to 82 deg. C (180 deg. F).
- 2.1.4. Ball valves 50 mm (2 in.) and smaller shall be lead free, 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. LFB-6000, Toyo 5044A-LF/5049A-LF, Kitz 858/859, Apollo 70LF-100/200, or NCI 600FP-T/S. Stem extensions shall be provided on all ball valves. Ball valves may be substituted for gate valves only.
- 2.1.5. Except where special features 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.
- 2.1.6. Thermostatic mixing valves
 - .1 Thermostatic mixing valves shall be Lawler Series 804 (38 mm (1-1/2 in.) inlet and 51 mm (2 in.) outlet) High-Low Water Mixer combination thermostatic and pressure balanced water controller, liquid filled motor. The valve shall maintain output temperature for changes in inlet pressure and temperature. Valve construction shall be bronze body and stainless steel piston and liner. Mixing valve shall include a union end

stop and check valve with removable strainer on each inlet. Complete with 0 - 200 deg. F. dial thermometer and shut off valve on tempered water outlet.

- 2.2. FLUSHING AND DISINFECTING:
- 2.2.1. Chlorine:
 - .1 Sodium hypochlorite to ANSI/AWWA B300 "Hypochlorites."
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Valves shall be provided 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. Isolation 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. Globe valves shall be installed as shown and in each bypass.
- 3.1.5. Install manual flow balancing valves where shown on the Drawings or where required.
- 3.1.6. Install reduced pressure backflow preventers where recommended by CSA B64 and in the following locations:
 - .1 Where shown on the Drawings
 - .2 As requested by the Authority Having Jurisdiction
- 3.1.7. Check valves shall be installed as shown and where required to prevent backflow.
- 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. Each water hammer arrester shall be accessible for service and replacement. They shall be installed in compliance with the recommendations of the Plumbing and Drainage Institute as found in Standard PDI-WH 201 "Water Hammer Arresters." The water pressure at fixture level on the first floor is 550 kPa (80 psig).
- 3.1.12. 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.
- 3.1.13. Provide an isolation valve downstream of all flow balancing valves on the domestic water distribution.
- 3.1.14. Provide all mechanical piping and fittings within the cistern. Rainwater cistern floating device shall intake water 150 mm below the water surface and shall ensure that the foot valve is always submerged.
- 3.1.15. Provide a thermostatic mixing valve on discharge of domestic hot water systems.

3.2. FLUSHING AND DISINFECTING

- 3.2.1. Flush and disinfect all new or reworked domestic water piping, ensure water flows through all fixtures, hose outlets, service connections and/or any other potable water outlet. Remove sediment from aerators as required.
- 3.2.2. Provide circulating pumps, connections and valves as required for complete flushing and disinfection of the system.
- 3.2.3. When flushing is complete, disinfect the piping with a solution of chlorine in accordance with ANSI/AWWA C651 "Disinfecting Water Mains."
- 3.2.4. Test water samples from disinfected water system at a certified laboratory for purity and conformance with governing standards.
 - .1 Submit a copy of the test results prior to building occupancy.

22 34 36.23 Domestic Gas Fired Hot Water Heater (Forced Draft)

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 SHOP DRAWINGS.
- 2. Products

2.1. MATERIALS

- 2.1.1. Storage tank with forced draft condensing type gas fired heater shall be as specified in equipment schedule.
- 2.1.2. Heater section shall be pure copper combustion chamber and tubes unless otherwise specified.
- 2.1.3. Heater section shall be complete with the following items:
 - .1 Burner for 97% efficiency
 - .2 Solid state flame safeguard
 - .3 Thermal expansion control valve
 - .4 Upper and lower operating thermostats
 - .5 Temperature high limit control
 - .6 ASME temperature and pressure relief valve
 - .7 Drain valve
 - .8 Manway
 - .9 Heavy insulated jacket
 - .10 Prefinished outer casing
 - .11 Minimum 862 kPa (125 psi) working pressure
 - .12 Thermometer
 - .13 Low water cut-off
 - .14 Damper
 - .15 Burner assembly complete with all regulating devices and suitable for 5-12" incoming gas pressure
 - .16 Gas reliefs piped to roof
 - .17 120 V control circuit
 - .18 Efficiency indicator with module protection device
 - .19 Rear module access

- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Connecting piping shall be installed to allow removal of heating element after disconnecting only two flanged pipe connections.

23 05 93.26 Testing and Balancing Air Systems

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. QUALITY ASSURANCE
- 1.2.1. Acceptable balancing companies are limited to the following:
 - .1 Design Test
 - .2 Pro-Air Testing Inc.
 - .3 VPG Associates
 - .4 Airwaso
 - .5 Leslie Danhart Inc.
 - .6 Air Audit
 - .7 Dynamic Flow Balancing Ltd.
 - .8 Vital Canada Group Inc.
 - .9 Design Test
- 2. Products
- 2.1. NOT USED
- 3. Execution
- 3.1. LEAKAGE TESTING
- 3.1.1. Duct Pressure Tests
 - .1 Perform pressure tests before ductwork is concealed or insulated.
 - .2 Follow SMACNA HVAC Air Duct Leakage Test Manual procedures.
 - .3 Provide blower and all test equipment.
 - .4 Test the percentage of ductwork indicated in the table below. If a test specimen fails to meet the specified air leakage criteria, modify fabrication methods to bring it into compliance and retest until acceptable duct air leakage is demonstrated. If pressure test fails any sample twice, increase percentage of ductwork tested as indicated in the rightmost column of the table below.
 - .5 Include as a minimum, 5 transverse joints, typical seams, an access door, 2 branch connections and 1 elbow in test samples.
 - .6 Ensure leakage amount does not exceed the allotted amount in the table below for the duct construction pressure class in question.
 - .7 Seal any leaks causing noise.

.8 Leakage Class:

Duct Construction Pressure Class	Rectangular Leakage Class	Round Leakage Class	Amount of Ductwork to be Tested	Percentage of Ductwork to be Tested if Test Fails any Sample Twice
10 in. w.g.	4	2	100 %	N/A
6 in. w.g.	4	2	100 %	N/A
4 in. w.g.	4	2	25 %	50 %
3 in. w.g.	8	4	25 %	50 %
1/2, 1, and 2 in. w.g.	16	8	10 %	20 %

.9 Submit testing report, including leakage calculations, as a submittal complying with the requirements of Section 20 05 03.00 – SHOP DRAWINGS.

- 3.1.2. Do not commence insulation installation until testing report is submitted to Engineer's Representative and is reviewed by Engineer's Representative without requesting a resubmit.
- 3.1.3. Refer to Section 23 31 13.00 DUCTWORK AND SPECIALTIES for pressure ratings of ductwork and systems.

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. Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to ensure correct air quantities.
- 3.2.3. Employ one of the qualified Independent Balancing Companies to balance the air systems.
- 3.2.4. The Independent Balancing Company measures and reports upon the air volume at each diffuser, register and grille. Report shall also show the air quantity handled by each fan, the static pressure upstream and downstream of the fan, the fan speed and the motor current. Also to be reported upon are the air flow at outdoor, return and exhaust air dampers under conditions of minimum outdoor air. All air volume shall be improved as per facilities preference or remain unchanged before and after the replacement of rooftop units.
- 3.2.5. Provide assistance to the air balancing company and shall provide control settings, new filters, and other incidentals and equipment required for the measurements.
- 3.2.6. 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.
- 3.2.7. 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.
- 3.2.9. Balancing company to review Mechanical Contractor's proposed access door locations and sizes per Section 20 05 63.00 ACCESS DOORS AND ACCESSIBILITY and ensure that sufficient access is available.

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23 09 00.03 Building Automation System (BAS)

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Connect new equipment to existing BAS.
- 1.1.2. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.3. Conform to Section 23 09 23.00 SEQUENCE OF OPERATION FOR BAS.
- 1.2. RELATED SECTIONS
- 1.2.1. Section 01 60 00.00 BASIC PRODUCT REQUIREMENTS
- 1.2.2. Section 20 05 14.00 WIRING AND STARTERS.
- 1.2.3. Section 20 08 00.00 COMMISSIONING.
- 1.2.4. Section 26 05 01.00 ELECTRICAL GENERAL REQUIREMENTS.

1.3. PROJECT SCOPE

- 1.3.1. Connect new rooftop units and domestic hot water heater and all associated components to existing BAS.
- 1.3.2. Create, delete and modify graphic representations of the controlled systems forming part of the scope of work.
- 1.4. SYSTEM OUTLINE
- 1.4.1. General
- 1.4.2. Mechanical Contractor to carry the cost of Controls Contractor.

1.5. BASE BUILDING BAS PROVIDER

- 1.5.1. Approved Suppliers And Manufacturers
 - .1 As identified on drawings.
- 1.6. Equipment Supplied For Installation Under Other Sections
- 1.6.1. Temperature sensor wells.
- 1.7. BAS Performance
- 1.7.1. Graphic Display: Display the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.7.2. Graphic Refresh: Update the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.7.3. Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every ten seconds.
- 1.7.4. Binary Object Command: Controlled device will react within five seconds of an operator initiated command on a binary point object.
- 1.7.5. Analog Object Command: Controlled device will start to react within five seconds of an operator initiated command on an analog point object.
- 1.7.6. Alarmed Object Display: Alarm will annunciate visually and audibly at Operator Interfaces within five seconds on local area networks and within forty-five seconds on wide-area networks from the time the object entered the alarmed state.
- 1.7.7. Program Execution Rate: Provide ability to execute programs at a minimum rate of once every five seconds. Provide execution rates suitable for processes controlled.
- 1.7.8. PID Execution Rate: Provide adjustable execution rates for proportional-integral-derivative (PID) loops; update the controlled variable and command the controlled device at this same rate. Provide execution rates suitable for processes controlled.
- 1.7.9. Display and Report Accuracy: Provide minimum accuracy for point object data displayed at Operator Interfaces, reported to printers, reported to data files to Table 1: Display and Report Accuracy.

Table 1: Display and Report Accuracy.		
Point Object	Accuracy	
Room Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual	
Duct Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual	
Outside Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual	
Dew Point Temperature	+/-1.5 deg. C (+/-2.7 deg. F) from actual	
Water Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual	
Relative Humidity	+/-2 % of actual for 20% to 80% RH at 25 deg. C (77 deg.F)	
Note 1: For both absolute and differential pressure.		
Note 2: Does not include utility grade meters.		

- 1 7 10 Control Tolorance: Maintain controlled variable to control tolorance from se
- 1.7.10. Control Tolerance: Maintain controlled variable to control tolerance from set point to Table 2: Control Tolerance.

Table 2: Control Tolerance.			
Controlled Variable	Range	Control Tolerance	
		from Set Point	
Room Temperature		+/-0.6 deg. C (+/-1.1 deg. F)	
Duct Temperature		+/-0.6 deg. C (+/-1.1 deg. F)	
Humidity		+/-5 % RH	
Air Flow		+/-1.0 % of scale length	
Air Pressure	0-1500 Pa (0-6 in. w.g.)	+/-1.0 % of scale length	
	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)	+/- 10.0 % of scale length	
Fluid Pressure (other than air)		+/- 1.0 % of scale length	

1.8. SUBMITTALS

- 1.8.1. Product Data and Shop Drawings:
 - .1 Within 30 days of award of contract, before start of construction, submit completely engineered and coordinated shop drawing package.
 - .2 Before start of construction, submit completely engineered and coordinated shop drawing package including graphics samples
 - .3 Submittals in printed format and as amended below.
 - .4 Provide drawing files through Electronic File Transfer.
 - .5 Specifications and Instructions: Indicate: dimensions, capacities, electrical characteristics, mechanical characteristics, environmental characteristics, performance characteristics, finishes. Circle model number for Products provided or furnished. General catalogue sheets are not acceptable. Provide installation instructions.
 - .6 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
 - .7 Products Schedule: Indicate: Product designation, Product name, Product manufacturer, Product model number, Product data sheet reference number, quantities. Provide quantities required under the Work.
 - .8 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple Drawings, indicate the control device with the same designation on all Drawings. Differentiate between manufacturer installed wire and field installed wire.
 - .9 Sequence of Operation: Provide a complete description of operation to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.
 - .10 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.
- 1.8.2. Work Schedule:
 - .1 Provide a schedule of the Work within four weeks of contract award. Indicate: intended sequence of tasks, start dates, task durations, and delivery dates for material and equipment requiring long lead times, restraints on Work by other trades or situations.
 - .2 Provide monthly updated Work Schedule indicating percentage complete and revisions to expected delivery dates.
- 1.8.3. Project as-built documents:
 - .1 Operation and Maintenance Manuals:
 - .1 Provide two copies in printed format for review by the Consultant at least ten weeks before the projected Substantial Completion date.
 - .2 Provide 1 copy of corrected manuals in printed format and three copies on Electronic File Transfer within three weeks following completion of Acceptance

Test under Part 3: Execution. Provide manuals in hard cover three-ring binders with index page and indexing tab per section.

- .3 Sections:
 - .1 Contact Information: Provide names, addresses, 24-hour telephone numbers of service representatives and installing Subcontractors.
 - .2 Operation: Provide Owner operating manuals for Operator Interfaces, Controller Resident Software, DDC Controllers, Advanced Application Controllers, Specific Application Controllers, control devices, compressed air system. For Custom Application Programs (Algorithms) Editor, provide a reference manual for the language syntax that describes each function.
 - .3 Engineering, Installation and Maintenance: Provide manuals for design and installation of point objects, controllers, and control devices. Provide instructions for calibrating, troubleshooting and replacing controllers and control devices.
 - .4 Software: Provide complete original issue media and release notes for Operator Interfaces.
 - .5 Preventive Maintenance Procedures: Provide for Operator Interfaces, controllers, control devices. Provide a schedule of tasks; indicate dates for inspection, maintenance and calibration; indicate the pages in the engineering, installation and maintenance manuals that list the procedures.
 - .6 Replacement Parts List: Indicate: manufacturer name, manufacturer model number, Supplier name, Supplier address, Supplier telephone number.
 - .7 Certificates: Provide original issue certificates for installation, maintenance and calibration.
 - .8 Test Forms: Provide copies of test forms completed under Part 3: Execution, Testing and Commissioning.
 - .9 Provide certificate of pressure test under Part 3: Execution, Control Air Tubing.
 - .10 Provide licenses, guarantees and warranty documents for Products and systems.
- .2 As-built Product data and Shop Drawings:
 - .1 Provide drawing files through Electronic File Transfer.
 - .2 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.
 - .3 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .3 As-built floor plans:
 - .1 Maintain on the Project site as-built conditions on one full-size set of Contract Drawings, referred to as marked-up drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.

- .2 Submit three copies of marked-up drawings to Consultant for review within three weeks following successful completion of Acceptance Test under Part 3: Execution. Revise Contract Drawings to match the approved marked-up drawings; revise using AUTOCAD Release 12 or higher format and submit three copies as full-size in printed format and two copies electronically in a means discussed in as-Built product data and Shop Drawings.
- .4 Software Backup:
 - .1 Provide with as-built Product data and Shop Drawings.
 - .2 Provide three copies of complete BAS databases on Electronic File Transfer.
- .5 Training Manuals:
 - .1 Provide a course outline, and one copy in printed format of training manuals provided under Part 3: Execution, Instruction and Training at least six weeks prior to the first class. Modify the course outline and training materials to suit Owner's requirements and as requested by the Consultant.

1.9. WARRANTY

- 1.9.1. Warrant the Work free from defects for a period of 12 months from substantial completion date and in accordance with the General Conditions and as amended below.
- 1.9.2. Warranty start date will be the date the Work is accepted under Part 3: Execution, Acceptance Test.
- 1.9.3. Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to the Owner. Provide warranty service during normal business hours and within 24 hours of the Owner's request for service.
- 1.9.4. Provide warranty service by factory trained service representatives of the Supplier.
- 1.9.5. Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to the Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
- 1.9.6. Prior to testing date under Part 3: Execution, Acceptance Test, update firmware in controllers to latest revisions at no additional cost to the Owner; update Operation and Maintenance Manuals with firmware release notes.
- 1.9.7. During the warranty period check the tuning of each control loop once during heating season and once during cooling season; notify the Owner when this Work is to occur. Forward to the Consultant documentation indicating observations and adjustments made.
- 1.9.8. Warrant Products that are reconditioned under the Work to the same requirements as new Products.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. Existing Products: To Part 3: Execution, Existing Products.
- 2.1.2. New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.

- 2.1.3. Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.
- 2.1.4. Revisions: Latest available revision for Controller Resident Software and controller firmware at start of Warranty.
- 2.1.5. Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.
- 2.1.6. Expansion: Expandable through additional inputs and outputs and to card access, security, fire alarm, lighting control systems and other building systems.

2.2. DDC CONTROLLERS

- 2.2.1. General
 - .1 Input/Output Interface:
 - .1 Analog Inputs:
 - .1 Signal: 4 to 20 mA, 0 to 10 VDC, thermistor, RTD.
 - .2 Binary Inputs:
 - .1 Detect dry contact closure.
 - .2 Wetting Current: Supplied by the controller.
 - .3 Pulsed Inputs:
 - .1 Detect pulse of dry contact closure.
 - .2 Pulse Frequency: Compatible with input device.
 - .3 Wetting Current: Supplied by the controller.
 - .4 Analog Outputs:
 - .1 Signal: 4 to 20 mA, 0 to 10 VDC. Provide range and zero adjustment.
 - .2 Accuracy Rating: +/- 1% of scale length.
 - .5 Binary Outputs:
 - .1 Triac: Rated for 0.5 A at 24 VAC
 - .2 Relay: NO or NC configuration, rated for 3 A at 24 VAC
 - .3 Provide secondary relay for higher loads.
 - .6 Minimum Spare I/O Capacity: Controllers to have minimum 20% spare capacity or at least one of each type of I/O available on the controller. This does not apply to Application Specific Controllers.
 - .2 Controllers that perform scheduling operations to have on board real-time clock.
 - .3 Controllers to continue to provide control functions in event of network communication failure.
 - .4 Controllers to be swappable without disconnecting the wiring.
 - .5 Immunity to Power: Rated for 90% to 110% of nominal voltage.
- 2.2.2. Building Controllers (BC):
 - .1 Independent, networked, microprocessor-based for all internetwork control strategies.
 - .2 Reside on Ethernet Tier 1 BAS network.

- .3 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces and provide global strategy and direction.
- .4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
- .5 Communicates to card access, security, fire alarm, lighting control systems.
- .6 Service communication port for communication with Portable Operator Terminals.
- .7 Memory: Non-volatile EEPROM for firmware. Seventy-two hours battery backed memory for object database and custom application programs.
- .8 Each BC to support firmware upgrades without need to replace hardware.
- .9 Environment: Suitable for anticipated ambient conditions.
- .10 Serviceability: LEDs for power, communication and processor status.
- 2.2.3. Advanced Application Controllers (AAC):
 - .1 Independent, networked, microprocessor-based.
 - .2 Reside on lower tier BAS network (BACNet or LON).
 - .3 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces.
 - .4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
 - .5 Service communication port for communication with Portable Operator Terminals.
 - .6 Memory: Non-volatile EEPROM for firmware. Seventy-two hours of battery backed memory for object database and custom application programs.
 - .7 Each AAC to support firmware upgrades without need to replace hardware.
 - .8 Environment: Suitable for anticipated ambient conditions.
 - .9 Serviceability: LEDs for power, communication and processor status.
- 2.2.4. Application Specific Controllers (ASC):
 - .1 Microprocessor-based networked. Non-adjustable programs with operator adjustable settings for customized operation within equipment design limits.
 - .2 Reside on lower tier BAS network (BACNet or LON).
 - .3 Service communication port for communication with Portable Operator Terminals.
 - .4 Memory: Non-volatile EEPROM memory for firmware and program data.
 - .5 Environment: Suitable for anticipated ambient conditions.
 - .6 Serviceability: LEDs for power, communication and processor status.

2.3. POWER SUPPLIES AND LINE FILTERING

- 2.3.1. Provide a separate power supply for every Building Controller, Advanced Application Controller and Application Specific Controller for terminal units.
- 2.3.2. Power Supplies:
- 2.3.3. Power Supply Voltage: 24 V, unless indicated otherwise on Drawings.

- 2.3.4. Type: Enclosed; Class 2 current-limiting, or over-current protection in primary and secondary circuits for Class 2 service to the National Electrical Code.
- 2.3.5. Applied Loads: To 80% of rated capacity.
- 2.3.6. DC Power Supplies: Regulated output.
- 2.3.7. Built in over voltage and over current protection.
- 2.3.8. Able to withstand 150% current overload for at least 3 seconds without trip or failure.
- 2.3.9. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers.
- 2.4. CABINETS
- 2.4.1. Type: NEMA rated and suitable for installed environment.
- 2.4.2. Door: Hinged with key-lock latch with common key for all cabinets; provide duplicate keys; for Application Specific Controllers provide screwed tight slide-off cover.
- 2.4.3. Controllers, transducers and relays mounted on backing board or DIN rails within inner section behind hinged doors.
- 2.5. CONTROL DEVICES
- 2.5.1. Electric Relays:
 - .1 Type: General purpose; enclosed coil; diodes provided for inductive switched loads; override button; LED "energized" indicator; plug-in type base.
 - .2 Contact rating, configuration and coil voltage suitable for application.
 - .3 Regulatory: UL listed.
- 2.5.2. Temperature Sensors:
 - .1 General Requirements:
 - .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.
 - .2 Space Temperature Sensors:
 - .1 Stainless Steel plate sensors or white-plate sensors For installation throughout the facility where local control is not required (such as corridors or lobby) unless otherwise noted.
 - .3 Space Temperature Sensors With Adjustable Set-Point, Override and Display:
 - .1 Key pad or slider for temperature set-point adjustment.
 - .2 LED display.
 - .3 Timed override request push button with LED status for activation of after-hours operation.
 - .4 For installation only where indicated on Drawings, controls diagrams or sequences of operations.
 - .4 Covers for Wall Mount Sensors:
 - .1 Overrides: Exposed set point adjustment and override button.
 - .2 Communication Port: For communication between Portable Operator Terminals and ASC controllers.
 - .5 Averaging Temperature Sensors:

- .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
- .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.
- .6 Duct Temperature Sensors:
 - .1 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - .2 Probe length shall be no less than 1/3 of the duct width or diameter.
 - .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
- .7 Thermowells:
 - .1 Brass or Type 316 stainless steel suitable for the application.
 - .2 Heat transfer compound compatible with sensing element.
- .8 Guards for Sensors and Thermostats:
 - .1 Materials: Heavy gauge steel.
- 2.5.3. Relative Humidity Sensors:
 - .1 Sensors shall be calibrated to NIST standards.
 - .2 Sensing Element:
 - .1 Type: Thin film capacitance.
 - .3 Transmitter:
 - .1 Range: 0 to 100% RH.
 - .2 Signal: 4 to 20 mA or 0-10 VDC with span and zero adjustment.
 - .4 Accuracy Rating: +/- 2 % of output reading.
 - .5 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure.
 - .6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- 2.5.4. Pressure Sensors:
 - .1 General:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing.
 - .2 Materials: Suitable for continuous contact with measured medium.
 - .2 Transmitter:
 - .1 Range: Not to exceed two times the operating pressure.
 - .2 Signal: 4 to 20 mA or 0-10 VDC; with zero and span adjustment.
 - .3 Accuracy Rating: +/- 1.0 % of full scale.
 - .4 Response Time: Maximum 0.5 seconds.
 - .3 Isolation Valve: Between process connection and sensor.
 - .1 Capable of withstanding 100% overpressure without damage
 - .4 Air Static Pressure Sensors:
 - .1 Sensing Element:

- .1 Type: Capacitance sensing with pitot tube sensing tips screwed securely to duct.
- 2.6. Wire And Conduit
- 2.6.1. Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.
- 2.6.2. Outlet boxes: Dry locations: sherardized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.
- 2.6.3. Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.
- 2.6.4. Wire:
 - .1 Network:
 - .2 Analog Input, Output: Stranded 18 gauge copper twisted shielded.
 - .3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
 - .4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.
 - .5 Plenum rated wiring to be used.
- 3. Execution
- 3.1. GENERAL WORKPERSONSHIP
- 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.
- 3.1.2. Install Products to manufacturer's installation instructions.
- 3.1.3. Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
- 3.1.4. Mechanical Contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
- 3.2. COORDINATION
- 3.2.1. Submittals: To Part 1: General, Submittals.
- 3.2.2. Integrate and coordinate Work under this section to controls and control devices provided or installed by others.
- 3.2.3. Each Supplier of control Product to configure, program, start-up and commission that Product to satisfy requirements of Sequence of Operation regardless of where within Contract Documents Product is described or specified.
- 3.2.4. Resolve compatibility issues between control Product provided under this section and those provided under other sections or divisions of this Specification.

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.
- 3.3.2. 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.
- 3.3.3. should it become necessary to splice field wiring it shall be soldered. If soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.
- 3.3.4. Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.
- 3.3.5. Plug or cap unused conduit openings and stubs with compatible fittings.
- 3.3.6. Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.
- 3.3.7. Provide watertight seals at penetrations through outside foundation walls.
- 3.3.8. Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with split-ring hangers and rods.
- 3.3.9. Maintain caps on conduit openings throughout construction.
- 3.3.10. Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- 3.3.11. Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.
- 3.3.12. Fill conduit to maximum of 60% of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.
- 3.3.13. Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.
- 3.3.14. All field sensors shall be provided with a flexible conduit connection minimum length of 450mm (18 in.) and an enclosure for the electrical connections.

3.4. POWER WIRING

- 3.4.1. Power for section 23 09 00.00 Building Automation System (BAS) shall be provided under Electrical Division 26 at 120 VAC 60 Hz single phase and shall terminate in junction boxes installed where shown on Electrical and/or Mechanical Drawings. Wiring and conduit from these boxes to control devices being electrically powered to be provided by section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 3.4.2. Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00.00 -BUILDING AUTOMATION SYSTEM (BAS) shall also be fed from the MCC from the 120 VAC section. Wiring and conduit from the MCC to control devices being electrically powered to be provided by section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).

3.5. COMMUNICATION WIRING

- 3.5.1. Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.
- 3.5.2. Install communication wiring in conduit and raceways separated from other wiring.
- 3.5.3. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 3.5.4. Each run of communication wiring to be continuous length without splices.
- 3.2.10. Provide data cables in conduit back to the closest data/telecom closet/room to allow all BAS head end equipment to connect to the network and all BAS controllers in the building as applicable to the project.
- 3.2.11. Ensure data cables are coordinated with requirements of BAS equipment based on submitted Shop Drawings.
- 3.5.5. Graphics: Generate graphic representations for systems under Section 23 09 23.00 SEQUENCE OF OPERATION FOR BAS and as follows:
 - .1 Building elevation in three dimensions; indicate: floors and mechanical rooms.
 - .2 Floor plans: Indicate: Equipment rooms; point object data for temperature, humidity and pressure. Directly access graphic representation for terminal systems.
 - .3 Equipment Rooms: Indicate locations for systems.
 - .4 Systems: Indicate: Equipment, service connections, point object data, set points, reset schedules. Highlight point objects under operator command.
 - .5 Graphic representations link to and display graphic representations for associated systems.

3.6. CONTROL DEVICES

- 3.6.1. 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 23 09 23.00 SEQUENCE OF OPERATION FOR BAS.
- 3.6.2. Provide or furnish control devices as indicated on the Drawings and to the requirements of this Section and to execute sequence of operations.
- 3.6.3. High Limit Electromechanical Thermostat:
 - .1 Install hardwire interlocked to fan starters for respective system.
 - .2 Shut down the fans when duct temperature is equal to or greater than 51.7 deg. C (125 deg. F).
 - .3 Provide one high-limit thermostat for each 3.7 sq M (40 sq ft) of duct cross section.
- 3.6.4. Electromechanical Thermostats and Temperature Sensors:
 - .1 Furnish sensing wells for installation under Section 22 11 13.00 PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
 - .2 Samples: Provide for wall mount type to Part 1: Submittals, Samples.
 - .3 Wall Mount Type:
 - .1 Cover Colour: White.
 - .2 Install to furred-in columns and permanent walls on concealed junction boxes supported by wall framing or surface mount 1.2 m (4 ft) above finished floor. Installation to mobile and temporary partitions is not acceptable.

- .3 Installation to exposed architectural concrete columns and walls is not acceptable, 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 Apply pipe sealing compound to plug thread.
- .5 Single Point Type, Pipe:
 - .1 Provide sufficient contact with process fluid to measure average conditions.
 - .2 Install with heat conducting fluid in wells.
- .6 Outdoor Type:
 - .1 Install to north side of building away from sources of heat such as lamps and exhaust vents; to greater than 1500 mm (5 ft) above horizontal surfaces.
 - .2 Where indicated or specified for installation in outside air intake, locate so as not to be affected by exhaust air flow or reverse flow.
 - .3 Provide solar shield. Install shield to open downward.
 - .4 Seal interior of conduit at penetration through exterior wall.
- 3.6.5. Guards for Thermostats and Temperature Sensors:
 - .1 Provide for wall mount sensors and thermostats where indicated on the Drawings.
 - .2 Samples: Provide to Part 1: Submittals, Samples.
- 3.7. IDENTIFICATION
- 3.7.1. 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.
- 3.7.2. All wires passing through a junction box shall be tagged with the device identity or its termination point.
- 3.7.3. The junction boxes shall be tagged "BAS" with a sequential number suffix.
- 3.7.4. Label wires, control devices, controllers.
- 3.8. TESTING AND COMMISSIONING
- 3.8.1. Test and commission the BAS prior to the Demonstration and Acceptance Test.
- 3.8.2. Test and commission the BAS prior to the Demonstration.
- 3.8.3. Prepare test forms which shall identify each test. The forms shall be sub-divided into:
 - .1 points, controllers
 - .2 programs, loopsnetworks and graphics.
- 3.8.4. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications.
- 3.8.5. Device tests shall identify and confirm successful completion of the following:
 - .1 Device installation.
 - .2 Device identification.

- .3 Device calibration.
- .4 Device operation.
- .5 Wiring to device, connection details and wire type.
- .6 Validation of the device signal at the controller.
- 3.8.6. Controller tests shall identify and confirm successful completion of the following:
 - .1 Controller installation.
 - .2 Power source and grounding.
 - .3 Make, model and serial number, software revisions.
- 3.8.7. Software tests shall identify and confirm successful completion of the following:
 - .1 Custom application programs.
 - .2 Alarm reporting.
 - .3 Trending and reports.
 - .4 Energy management programs.
- 3.8.8. Loop tuning tests shall identify and confirm successful completion of the following:
 - .1 Loop input signal.
 - .2 Loop output signal.
 - .3 Set point adjustment.
 - .4 Device response.
 - .5 Control response.
- 3.8.9. Network communication tests shall identify and confirm successful completion of the following:
 - .1 Primary network communication function.
 - .2 Secondary network communication function.
 - .3 Alarm reporting function.
 - .4 Operator communication.
- 3.8.10. Dynamic graphics tests shall identify and confirm successful completion of the following
 - .1 All graphics.
 - .2 All point objects per graphic.
 - .3 All set-points per graphic.

3.9. DEMONSTRATION

- 3.9.1. 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. At the successful conclusion of this demonstration the Consultant will allow the Acceptance Test to begin.
- 3.9.2. 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 controls are operating.
- 3.9.3. At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. Should any test fail then the BAS Contractor shall retest the failed components or functionality.

3.10. INSTRUCTION AND TRAINING

3.10.1. Provide instruction that shall cover the operation and maintenance of the control systems.

23 09 23.00 Sequence of Operation for BAS

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and SECTION 23 09 00.00 BUILDING AUTOMATION SYSTEM (BAS).
- 1.1.2. The locations of all sensors shall be discussed with and approved by the Owner and/or Engineer's Representative, before installation. Locations shown are approximate only, and are given to assist the Contractor in pricing only, and shall not be construed as being the final approved location.
- 1.1.3. The control sequence descriptions are complementary. Provide detailed sequences of operation and all points required to implement the sequences.
- 1.1.4. All settings and set points listed in this Section shall be variable and Operator adjustable without the need to create or modify Custom Application Programs.
- 1.1.5. All set points and reset schedules shall be visual on the associated dynamic graphic.
- 1.1.6. Where the project includes an existing BAS, ensure that any upgrades to the existing BAS for this project scope does not negatively impact existing BAS infrastructure. Maintain the functionality of existing controls not revised by this scope of work.
- 2. Products
- 2.1. GENERAL APPLICATION PROGRAMS
- 2.1.1. Provide a specific set of programs to achieve automated, operator independent control of facility sub-systems.
- 2.1.2. Refer to SECTION 23 09 00.00 BUILDING AUTOMATION SYSTEM (BAS) for software programs.
- 3. Execution

3.1. DOMESTIC HOT WATER TANKS AND RECIRCULATION PUMP

- 3.1.1. Normal Operation:
 - .1 The BAS shall monitor each domestic hot water tank temperature.
 - .2 The controls provided with each domestic hot water tank shall maintain tank temperature set-point.
 - .3 The BAS shall modulate the domestic water mixing valve to maintain the domestic hot water supply temperature.
 - .4 During occupied hours, domestic hot water recirculation pump shall run continuously.
 - .5 The BAS shall monitor the DHW supply temperature at the outlet of the tank and at a remote location downstream in the domestic water system as indicated on site by the Consultant.

- .6 During unoccupied hours, the BAS shall start the domestic hot water recirculation pump when the remote supply temperature falls below the minimum supply water set-point (initially set at 37.8 deg. C. (100 deg. F.)).
- .7 The BAS shall stop the domestic hot water circulator when the remote temperature is maintained at a minimum of 51.7 deg. C. (125 deg. F.) for 10 minutes.

3.1.2. Alarms:

- .1 Domestic Water Recirculation Pump (DWRPST) from current sensor.
- .2 Domestic Hot Water Tank Temperature (DHWTT) out of range.
- .3 Domestic Hot Water Supply Temperature (DHWST) out of range.

3.2. NEW ROOFTOP UNITS

- 3.2.1. Applicable Systems:
 - .1 Existing Sequence to remain.
- 3.2.2. System Start:
 - .1 System start shall be initiated by operator command at the BAS or through time schedule. Upon signal to start the system supply fan shall start. Unit's internal controls shall be enabled.
- 3.2.3. Normal Operation:
 - .1 Supply Fan (SFSS) shall run continuously in occupied mode.
 - .2 Economizer shall be controlled by unit's internal controls.
 - .3 Cooling and heating stages shall cycle in sequence to maintain Space Temperature (SPCT) at set-point (adjustable).
 - .4 When in unoccupied mode, the unit shall cycle if necessary to maintain the night setback space temperature set-point.
- 3.2.4. System Stop:
 - .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system the supply fan shall stop. Unit's internal controls shall be disabled.
- 3.2.5. Schedule:
 - .1 To be determined by the owner.
- 3.2.6. Alarms:
 - .1 Supply Fan Status (SFST) from current sensor.
 - .2 Return Air Temperature (RAT) out of range.
 - .3 Space Temperature (SPCT) out of range.
 - .4 Static pressure sensor out of range.
 - .5 Carbon Dioxide sensor out of range.
 - .6 Filter clogged

23 11 23.00 Natural Gas Piping Systems

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Conform to Section 23 35 16.00 ELECTRIC POWER GENERATOR.
- 1.2. REFERENCE
- 1.2.1. CSA B149.1 Natural gas and propane installation code, latest edition.
- 2. Products

2.1. MATERIALS

- 2.1.1. Pipe and fittings for 860 kPa (125 psi) and lower, fully welded as accepted by Authority Having Jurisdiction:
 - .1 Schedule 40 steel, ASTM A106 or ASTM A53 up to 250 mm (NPS 10)
 - .2 Standard weight steel, ASTM A106 or ASTM A53 larger than 250 mm (NPS 10)
 - .3 Steel fittings, ANSI/ASME B16.3, Welded
 - .4 Malleable Iron fittings, threaded, up to 50 mm (2 in.) diameter for connections close to equipment and dirt pockets
 - .5 Factory-applied, three-layer coating of epoxy, adhesive, and PE protective coating for underground steel pipe.
 - .1 Epoxy paint, adhesive, and heat-shrink PE sleeves joint cover kits.
- 2.1.2. Manual valves for 860 kPa (125 psi) and lower, as accepted by the Authority Having Jurisdiction:
 - .1 Ball or plug type
 - .2 CSA/CGA B3.16
 - .3 Supervisory switch (where specified or shown)
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Provide pressure reducing valves and overprotection devices where shown or as required for conformance with CSA B149.1 for equipment supplied under this Contract.
- 3.1.2. Pipe relief from pressure reducing valves to outdoors. Vent-less pressure reducing valves may be used where permitted by the Authority Having Jurisdiction.
- 3.1.3. Weld all distribution piping within the building, and utilize screwed and/or flanged fittings at equipment only.

- 3.1.4. Paint natural gas piping in its entirety an approved colour in accordance with CSA B149.1. Banding is not permitted.
- 3.1.5. Provide thermal expansion control for gas piping on the roof as required by CSA B149.1.

23 22 53.00 Pressure Relief Valves

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 2. Products

2.1. MATERIALS

- 2.1.1. All pressure relief valves shall be code rated for the service and shall be approved under Canadian Interprovincial Boiler Inspection Regulations.
- 2.1.2. Pressure relief valves shall be Spirax Sarco or approved equal.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Hot water pressure relief valves shall operate at 207 kPa (30 psi) unless shown otherwise. Where higher pressure relief settings are required, relief valve shall operate at 70 kPa (10 psi) less than the maximum rated pressure of the lowest rated system component (tank, boiler, heat exchanger, etc.) or 1034 kPa (150 psi) whichever is less.

23 31 13.00 Ductwork and Specialties

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 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 the Work in the appropriate discipline. Same design engineer stamps each and every Shop Drawing.
- 1.2.2. Samples: Submit samples as required.
- 1.2.3. Submit marked up prints showing detailed locations of all devices mounted in or on ductwork, dimensioning their locations.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A653/A653M.
- 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. Access Ports shall be Lawson-Taylor or other approved manufacture of 32 mm (1-1/4 in.) dia. ports.
- 2.1.4. Flexible Connections:
 - .1 Ventfabrics, Duro Dyne or Dyne-Air.
 - .2 For fans less than 0.5 kPa (2 in. wg.) connections shall be minimum 680 gm/sq.m. (20 oz./sq.yd.) fire retardant polyvinyl-chloride polyester fabric equal to Vinyl-Flex.
 - .3 For fans in excess of 0.5 kPa (2 in. wg.) connections shall be minimum 1,080 gm/sq.m. (32 oz/sq.yd.) non-toxic neoprene coated fibreglass fabric equal to Neoprene N.T.
 - .4 For all flexible connections located outside the building (e.g. roof top units) flexible connections shall be fire retardant Hypalon coated fibreglass fabric and shall be a minimum 9915 gm/sq.m. (27 oz./sq.yd.) equal to Hypalon.
 - .5 For all systems where the temperature may exceed 112 deg. C. (235 deg. F.) silicone rubber coated fibreglass shall be used, and shall be equal to Silicone H1-T. Submit flexible connections for review before installation.
- 2.1.5. Dampers:

- .1 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. Where a fire damper is required to be installed behind a wall grille, Slimline type dampers may be used to provide a flush to wall grille installation.
 - .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 Thermally insulated motorized control dampers: in accordance with the requirements contained within Section 23 09 00 BUILDING AUTOMATION SYSTEM (BAS).
- 2.1.6. Acoustic Insulation: 25 mm (1 in.) thick rigid coated glass fibre.
- 2.1.7. Interior Duct Protective Coating: Chlorinated rubber base paint or Eisenheiss Black.
- 2.1.8. 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 Provide single thickness turning vanes built to and supported at intervals dictated by SMACNA HVAC Duct Construction Standards Metal and Flexible. Provide rails securely set in the elbow so that they cannot loosen.
- 2.1.9. Provide following duct penetrations with barred duct inserts to restrict passage for minimum and maximum security applications:
 - .1 Barred ductwork insert shall be 5 mm (3/16 in.) welded steel on all four sides with 19 mm (3/4 in.) solid round security bars on 150 mm (6in.) centres with 65 mm x 5 mm (2-1/2 in. x 3/8 in.) security bars on sizes exceeding 300 mm (12 in.). Angle frame shall be 5 mm (3/16 in.) steel angle (one welded to unit and one shipped loose for field welding). Install per manufacturer's current installation instructions.

2.2. FABRICATION

2.2.2. 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. Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.
- 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. Low pressure ductwork 0.5 kPa (2 in. wg) static pressure and less as follows:
 - .1 Rectangular/round duct location:
 - .1 Ductwork serving fans with an external static pressure of 0.5 kPa (2 in. wg) or less.
 - .2 Downstream of terminal heating and cooling devices.
 - .2 Seal ducts to Seal Class C in accordance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "HVAC Air Duct Leakage Test Manual."
 - .3 SMACNA leakage class:
 - .1 Rectangular ductwork: 16
 - .2 Round ductwork: 8
 - .4 Refer to tables for low pressure rectangular duct construction and round duct construction below for further duct construction requirements.
- 3.1.6. Seal all joints of all ducts. Brush joints with the compound before and again after assembly. Seal any leaks causing noise.
- 3.1.7. Seal the bottom and side joints of outside air ducts or plenums water-tight.
- 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 Engineer's Representative.
- 3.1.10. Select the gauge of metal and method of construction for the new size. Notify the Engineer's Representative 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 Engineer's Representative 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 Engineer's Representative and the testing company before installation.
- 3.1.14. Provide flexible connections at each air handling unit (where not provided internally) and fan duct connections before and after any required transitions on the fan inlet and outlet respectively (i.e. on the largest duct perimeter and not directly installed on the fan inlet and outlet to reduce noise and air turbulence).
- 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. Provide splitter dampers as shown on Standard Details.
- 3.1.17. Incorporate counterbalanced backdraft dampers where shown. Adjust counterweights to the minimum pressure required to relieve the system pressure. Incorporate gravity backdraft dampers where shown.
- 3.1.18. Install motorized dampers where directed.
- 3.1.19. Install fire dampers where shown and at all penetrations through all fire rated assemblies. Provide firestop flap type fire dampers where fire dampers are shown in grilles or diffusers at ceiling level. Provide the appropriate fire damper model to suit the installation condition and provide all necessary flanges, frames, fittings, and accessories to ensure a flush installation. Obtain local authorities' approvals for all damper locations and keep one set of marked-up prints on site. Approvals shall be obtained before installation of fire dampers.
- 3.1.20. Where a fire damper is required to be installed behind a wall mounted grille, provide damper, angles, and retaining devices as required to provide a smooth, flat to wall installation.
- 3.1.21. Where fire dampers for ducts shown on Drawings require a change of type and/or powered actuation due to dimension limitations to satisfy the UL 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.
- 3.1.22. Receive automatic dampers from separate Section on site, and set in place under the supervision of the control manufacturer.
- 3.1.23. 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.) or full width of duct if less than 450 mm (18 in.) wide. Panels shall be of double wall construction and shall be internally insulated on insulated ducts. Frame shall be of structural angle with welded corners, gasketed to receive the panel. Panel shall be held in place with 4 window sash locks.
- 3.1.24. Paint visible internal surface behind each grille or register flat black.
- 3.1.25. Where duct is acoustically lined, duct dimensions shown are net, inside of lining.
- 3.1.26. 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.

- 3.1.27. Air wells shall be 1.95 mm thick (0.0767 in 14 GSG gauge) galvanized steel construction with all joints welded. Clean all welds so that no water traps occur. Touch-up all welds with zinc rich primer. Suitably brace the entire assembly with steel angle to prevent flexing and drumming. Coat the entire surface exposed to the outside air with 2 coats of rustproofing finish. Submit sample of rustproofing for review. Provide a structural supporting frame to support the entire unit plus an additional live loading of 4.2 kg/sg.m. (100 lbs/sg.ft.).
- 3.1.28. Spin-in connections shall only be used downstream of variable volume boxes.
- 3.1.29. Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.
- 3.1.30. All exposed open ends of ductwork located less than 2000 mm (79 in) above the finished floor 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. The screen shall be installed and painted matte black and shall not be capable of passage of anything larger than a 15 mm (1/2 in.) sphere through the openings.

23 51 33.00 Positive Pressure Vent and Chimney Systems

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Shop Drawings: Submit Shop Drawings of the entire system being supplied, including details and catalogue cuts of any standard components being incorporated into the system.
- 1.2.2. Design and install system layout in compliance with manufacturer's written installation instructions and all applicable local codes.
- 1.2.3. Provide details for chimney support system, including all guy wire locations, wind loads, etc. as required.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. Provide vent and chimney system that is continuous from the appliance's flue outlet to the termination to atmosphere outside the building. Provide system components that are ULC Listed and supplied from the same manufacturer.
- 2.1.2. Provide stainless steel guy wires and accessories with all necessary components for proper support.
- 2.1.3. Double Wall, positive pressure, condensing or non-condensing low heat applications
 - .1 Size vent and chimney system to suit natural gas appliance, factory built, suitable for Category I, II, III or IV condensing or non-condensing appliances or as specified by the appliance manufacturer. ULC Listed for maximum continuous flue gas temperature of 249 Deg. C. (480 Deg. F.) and a minimum positive pressure rating of 1.49 kPa (6 in. W.C.) and tested at 8.72 kPa (35 in. W.C.).
 - .2 Include with system:
 - .1 Type AL29-4C stainless steel inner liner, with a minimum wall thickness of 0.381 mm (0.015 in.) for 76.2 mm (3 in.) through 228.6 mm (9 in.) diameter vents, 0.508 mm (0.020 in.) for 254 mm (10 in). through 406.4 mm (16 in.) and 0.61 mm (0.024 in.) for 457 mm (18 in.) through 610 mm (24 in.) diameter vents.
 - .2 Type 304 stainless steel non-corrosive outer casing, with a minimum wall thickness of 0.41 mm (0.016 in.) for 76.2 mm (3 in.) through 152 mm (6 in.), 0.61 mm (0.024 in.) for 178 mm (7 in.) through 406.4 mm (16 in.) for outdoor portion of system.
 - .3 25 mm (1 in.) air space between the flue and jacket. For any venting lengths with 1200 mm (4 ft) exposed to the exterior, provide a 50 mm (2 in) gap filled with glass fiber insulation.

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- .4 All section joints with a triple lipped directional silicone gasket for sealing and a built in mechanical locking band.
- .5 All necessary braces, supports, cleanouts at the end of each horizontal section, roof flashings, roof and wall penetrations, storm collars, base support, and flue termination.
- .6 Utilize low-loss rain cap or double cone rain cap terminations on non-condensing applications only. Utilize velocity cone or straight terminations on condensing systems.
- .3 ULC Listed for 50 mm (2 in.) clearance to combustibles.
- .4 Acceptable chimney and breeching systems:
 - .1 Selkirk type CI Plus
 - .2 Schebler Co. model eVent
 - .3 Duravent Duraseal
 - .4 Security Chimneys Secureseal
 - .5 Chiminèe Lining model IPPL
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Route the vent system to maintain minimum clearance to combustibles as specified by the manufacturer.
- 3.1.2. Conform to the manufacturer's written installation instructions, ULC Listing and the requirements of the Authority Having Jurisdiction.
- 3.1.3. Inspect and clean the system before the final connection to the appliances.
- 3.1.4. Support any dampers or fans installed in conjunction with the vent system independently from the vent system. Protect the vent system from twisting or movement due to fan torque or vibration.
- 3.1.5. Provide chimney height of at least 900 mm (3 ft.) higher than any portion of the building within 3000 mm (10 ft.). and self-support up to 1800 mm (6 ft.) as appropriate to suit diameter.
- 3.1.6. Run guy wires, where required, from chimney to guy wire supports located approximately mid-span of beams. Refer to Structural Drawings for locations.

23 74 13.13 Small Packaged (Modular) Roof Mounted Air Conditioning Units

- 1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 20 05 00.00 GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.2. SUBMITTALS
- 1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).
- 2. Products
- 2.1. MATERIALS
- 2.1.1. Packaged roof top units shall be Aaon, Daikin, Carrier, Lennox, or JCI York.
- 2.1.2. Units shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Cooling capacity, heating capacity and fan performance shall be ARI certified. Complete unit shall be ETL- Canada listed.
- 2.1.3. Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 25,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- 2.1.4. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply and return fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, test and adjustment of the gas furnace, a unit refrigerant leak test and a final unit inspection.
- 2.1.5. Each unit shall be complete with all components required for a complete and operational system, including but not limited to the following:
 - .1 ECM variable speed supply air fan section with centrifugal fans.
 - .2 Air cooled refrigeration section
 - .3 In-direct Natural gas-fired heating section
 - .4 Economizer fan and damper section
 - .5 Roof top enclosure
 - .6 Remote space 7 Day Programmable Heating/cooling thermostat with Tenant Override capability
 - .7 Filter section
 - .8 Roof mounting frame and curb
 - .9 Gas pressure regulator
 - .10 Enthalpy wheel heat recovery section
- 2.1.6. Provide weatherproof rooftop enclosure for all above components, complete with an outside air inlet. Factory install piping and wiring of all components, complete with all safety and operating controls, and make ready for field connection of power and thermostat wiring to terminal strip, and gas piping to gas inlet.

2.1.7. Each unit shall have the capacity shown in the Roof Top Unit Schedules with 35 deg. C. (95 deg. F.) ambient air entering the condenser.

2.2. CASING

- 2.2.1. Exterior panels shall be double-wall construction. Insulation shall be a minimum of 1" thick with an R-value of 4.0, and shall be neoprene coated glass fiber. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance.
- 2.2.2. The frame and unit base shall be heavy gauge galvanized steel. Unit base shall overhang the roof curb for water runoff and shall have a formed recess that seats on the roof curb gasketing to provide a positive weather tight seal
- 2.2.3. Service doors shall be provided for the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- 2.2.4. Stainless steel drain pans shall be sloped in two directions and comply with ASHRAE Standard 62.1. The drain pan shall extend beyond the leaving side of the coil.

2.3. FAN SECTION

- 2.3.1. Supply air fan shall be centrifugal with capacity to deliver the air quantity shown as outlined in the Roof Top Unit Schedule in tender mechanical drawing. Reinforce casings to prevent drumming.
- 2.3.2. Fan assemblies shall be statically and dynamically balanced for quiet operation. Provide slide out rails for servicing and maintenance of the fan. All fan assemblies shall employ solid steel fan shafts. Bearings shall be sized to provide an L-50 life of 250,000 hours.
- 2.3.3. The fan assembly shall have adjustable pitched sheaves on the motor. Bushings shall be used on all sheaves to allow for easy removal of the pulleys from the fan and motor shaft. Fixed bore pulleys fastened to the shaft by setscrews will not be allowed. The drives shall be selected with a 1.2 service factor.
- 2.3.4. Variable air volume systems, or units serving single zones shall be provided with variable speed drives to reduce airflow at cooling loads below 50% per ASHRAE 90.1-2010.
- 2.3.5. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. Acceptable alternate is a premium efficiency open drip proof motor suitable for use with a variable speed drive. Motor safeties shall include thermal overload protection and phase failure protection. Provide variable speed drive integral with the unit. If VFDs are used, note that harmonic filters are not integrated with the unit.

2.4. FILTER SECTION

1.1.1. Filter section shall be complete with Farr D/C or other approved manufacturer of 50 mm (2 in.) thick pre-filter consisting of throw away media in permanent frames. Media shall have an efficiency of (2 inch Merv 13-85%) (4 inch Merv 14-95%).

2.5. ECONOMIZER

2.5.1. Unit shall be provided with an outdoor air economizer section. The economizer shall include outdoor, return, and exhaust air dampers. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit.

- 2.5.2. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be opposed blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 4 cfm / square foot of damper area at 1" differential pressure per ASHRAE 90.1 Energy Standard.
- 2.5.3. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. If powered economiser is to be provided, delete barometric
- 2.5.4. Powered economizer shall provide free cooling using up to 100% outside air at all outside temperatures below 23.9 deg. C. (75 deg. F.) and minimum of approximately 10% outside air shall be provided above this temperature. Outside air damper shall close when unit is shut down. Include powered economiser option depending on return air path conditions Exhaust fans shall be direct drive, axial type. Blades shall be constructed with fabricated steel and shall be securely attached to fan shafts. All exhaust fan assemblies shall be statically and dynamically balanced. Motors shall be permanently lubricated, heavy-duty type, carefully matched to the fan load. Ground and polished steel fan shafts shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds.
- 2.5.5. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

2.6. REFRIGERATION AND CONDENSING SECTIONS

- 2.6.1. Coils shall have seamless copper tubes, mechanically bonded to aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes.
- 2.6.2. Air cooled refrigeration section shall provide stable operation down to 12.8 deg. C. (55 deg. F.) Only include where required, otherwise economiser will be sufficient outside air temperature.
- 2.6.3. Optional low ambient cooling to 0 degrees F shall be provided. Include only if required, otherwise delete.
- 2.6.4. Condenser fans shall be direct drive, axial type designed for low tip speed and vertical air discharge These fans are standard arrangement. Choose this option or paragraph below to upgrade to EC. Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
- 2.6.5. Fan motors shall be ECM type. The rooftop controller shall proportionally control the speed This is an option on only a few available units. Confirm requirement for Project of the condenser fan motors to maintain the head pressure of the refrigerant circuit within acceptable limits. Mechanical cooling shall be provided to 0° F. Motor safeties shall include thermal overload protection and phase failure protection.
- 2.6.6. The condenser fan shall be dynamically designed for low noise generation with low tip speeds. Fan blade shall be of a composite material. The maximum sound power level shall be xx/xx/xx/xx for the 2nd/3rd/4th/5th power bands respectively. Choose the composite/profile fan for Projects that required reduced sound power levels at the condenser.
- 2.6.7. All units of 6.5 ton capacity and above shall have minimum two independent refrigeration circuits.

- 2.6.8. Each circuit shall have fan cycling on at least one condenser fan to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 20° F.
- 2.6.9. Each unit shall have multiple, heavy-duty scroll compressors. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
- 2.6.10. Variable Speed Compressors Confirm availability of this option. This is an upgrade for additional energy savings.
 - .1 The unit shall have multiple scroll compressors. One of the compressors shall be inverter driven and the unit controller must control the speed of the compressor to maintain the discharge air temperature.
- 2.6.11. Each circuit shall be complete with isolation ball valves on the suction and discharge sides of the compressor, a low pressure control, filter-drier, liquid moisture indicator/sight-glass, thermostatic expansion valve, and a manual reset high pressure safety switch. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation.
- 2.6.12. The refrigeration circuit shall have both low and high pressure safety switches. Temperature sensors shall be provided for measuring suction and discharge temperature of the refrigerant.
- 2.6.13. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for compressor start-up under low head pressure conditions. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- 2.6.14. Each circuit shall be dehydrated and factory charged with Refrigerant and oil.

2.7. HEATING SECTION

- 2.7.1. Natural gas fired heating section shall provide indirect heating through an aluminized steel or stainless steel heat exchanger if the return air is greater than 30% of the outside air volume; or Type 409 stainless steel heat exchanger if the return air is less than 30% of the outside air volume. Provide electric ignition with remote flame sensor. Unit shall be suitable for 1.74 kPa (7 in.wg.) gas pressure. The natural gas section shall be capable of modulating at a 10:1 staging ratio. ONLY USE STAINLESS STEEL FOR 100% OUTSIDE AIR UNIT. REVISE GAS PRESSURE AS REQUIRED. Revise stating as required. Units 20 tons and less have staged heating, 25 tons and over 10:1
- 2.7.2. Electric heating coils shall be of the open resistance element type of 80% nickel and 20% chromium. Elements shall be uniformly distributed over the cross sectional area of the unit with vertical support brackets to prevent coil element sag. Coil elements shall be insulated from metal by ceramic bushings. Provide expanded steel baffle on coil inlet for uniform airflow. Electric coils shall be provided with built-in primary automatic and secondary manual reset thermal protection devices and static pressure type airflow switch to prevent energization when airflow is inadequate. Delete electric heat if not required.
- 2.7.3. Provide electric coils with variable control achieved by a duct mounted thermostat and SCR controller. Provide control panel with a unit mounted circuit breaker size for interrupting capacity as to meet CSA requirements.

2.7.4. Control panels shall be integral to the heating coil (remote mounted). Control panels shall be of CSA construction with magnetic circuit fusing for each 48 amp circuit to meet CSA requirements, SCR controller and 120 volt fused control power transformer sized as required. All control and safety devices shall be factory wired as to meet CSA requirements. Thermostat provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).

2.8. ELECTRICAL

- 2.8.1. Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with all applicable UL and CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized where applicable.
- 2.8.2. Unit shall be suitable for 575/3/60 or 208/3/60 power supply as scheduled. Select a suitable voltage
- 2.8.3. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 120 volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.
- 2.8.4. Provide mechanical screw-type lugs designed for copper conductors and sized to handle 125% of total heater load in the control panel for terminating power wiring. Provide a complete wiring diagram permanently attached to the inside of the control panel cover.
- 2.8.5. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
- 2.8.6. A GFI receptacle shall be unit mounted. The receptacle shall be powered by a factory installed and wired 120 V, 20 amp power supply. The power supply shall be wired to the line side of the unit's main disconnect, so the receptacle is powered when the main unit disconnect is off. This option shall include a GFI receptacle, transformer, and a branch circuit disconnect.

2.9. ROOF CURB

- 1.1.2. Provide an insulated adapter curb for each rooftop unit supplied under this scope to ensure the new rooftop unit can interface with the existing rooftop curb. This adapter curb shall mate with the unit frame and be of the same thickness.
- 1.1.3. Adapter curb shall be prefabricated 14-gauge galvanized steel, mounting curb for field assembly on the existing curb. Secure the curb to the existing curb and rooftop unit including weather stripping, sealant and make air and water tight.

2.10. CONTROLS

- 2.10.1. Each unit shall be equipped with a microprocessor based direct digital control (DDC) system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including scheduling, unit diagnostics and safeties.
- 2.10.2. The stand-alone microprocessor controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand-alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in non-volatile memory. No settings shall be lost, even during extended power shutdowns.

- 2.10.3. The microprocessor control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- 2.10.4. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- 2.10.5. The microprocessor controller shall have a built-in adjustable time schedule. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- 2.10.6. The unit is to be programmed with a night setback or setup function, with a signal provided from a space sensor. Sensor options shall include a zone sensor with tenant override switch plus heating and cooling set point adjustment.
- 2.10.7. Provide a seven day programmable heating/cooling thermostat with integral selection switch for each unit. Provide a key-locked tamper-proof cover for each thermostat.
- 2.10.8. At the main micro-processor controller provide a unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - .1 Return air temperature
 - .2 Discharge air temperature
 - .3 Outdoor air temperature
 - .4 Space air temp
 - .5 Outdoor enthalpy, high/low
 - .6 Dirty filter indication
 - .7 Airflow verification
 - .8 Cooling status
 - .9 Control temperature (Changeover)
 - .10 VAV box output status
 - .11 Cooling status/capacity
 - .12 Unit status
 - .13 All time schedules
 - .14 Active alarms w/time and date
 - .15 Previous alarms with time and date
 - .1 Optimal start
 - .2 System operating hours
 - .3 Fan
 - .4 Exhaust fan
 - .5 Cooling
 - .6 Individual compressor
 - .7 Heating
 - .8 Economizer
 - .9 Tenant override

- 2.10.9. For variable air volume systems, the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
 - .1 Airflow
 - .2 Outside air temperature
 - .3 Space Temperature
 - .4 Return air temperature
 - .5 External signal of 1-5 VDC
 - .6 External signal of 0-20 mA
 - .7 Network signal
- 2.10.10. On constant volume applications, the DDC controller shall include a supply air fan speed reset sequence. The speed of the supply fan shall be modulated from high speed to low speed based on: Include the supply fan reset sequence for constant volume applications
 - .1 Status of Compressor staging
- 2.10.11. The unit control system shall have the ability to communicate to an independent Building Management System through a direct (BACnet Ethernet) (BACnet MSTP) (LonTalk) communication connection. The independent BMS system shall have access to "read only" variables and "read & and write" variables. Communications shall not require field mounting of any additional sensors or devices at the unit.

2.11. SEQUENCE OF OPERATION

- 2.11.1. The unit shall be controlled on a time of day. The unit shall accept the programmed room temperature setpoint based on time of day, and current room temperature.
- 2.11.2. The supply air fan shall remain operational when the space is in occupied mode.
- 2.11.3. On a call for cooling, the RTU controller shall modulate both the supply air fan and the D/X cooling stages in sequence to maintain the current space temperature setpoint based on the current space conditions. When the cooling demand is less than 50%, the controller shall reduce the fan speed accordingly.
- 2.11.4. On a call for heating, the RTU shall operate the fan at 50% (programmable) speed and modulate the gas burner to maintain the current space temperature setpoint based on the current space conditions.
- 2.11.5. When the RTU is in un-occupied mode, the fan shall cycle with the D/X cooling stages and the gas burner as required to maintain the space unoccupied setpoint.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Provide all control wiring from thermostat and thermostat sub-base.
- 3.1.2. Supply and install wiring of the airflow switch for the electrical coil.
- 3.1.3. Gas fired roof top unit shall not be installed closer than 2 m (6 ft.) to the edge of the roof.
- 3.1.4. BAS connection to the unit provided under Section 23 09 00.00 BUILDING AUTOMATION SYSTEM (BAS).
- 3.1.5. Start up and test all unit functions and ensure proper operation. Factory technician to provide copy of start-up log to Owner and to demonstrate operation and maintenance to Owner.