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APPENDIX A

- DFL Campus Procedures
- DFL Project General Notes & Procedures
- DFL Cleanroom Procedures

APPENDIX B

- Waste Traceability Grid (MS Excel File)

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| | E3 | Mech Room M6 Power & Systems Demo & New Work Phase 1 |
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Part 1 General

1.1 INTENT

- .1 Intent of this Tender call is to obtain a firm price offer to upgrade and refit the Heating Ventilating Air Conditioning System serving the ISO 14644 Class 7 Clean Room Bay 3 at the Canadian Space Agency's David Florida Laboratory, 3701 Carling Avenue, Ottawa Ontario, in accordance with these Tender Documents and complete in every respect for a fully operational system (electrical connections, controls, fire alarm connection, programming, commissioning, ductwork, piping etc.).
- .2 Demolition and partial removal of ductwork currently serving the ISO 14644 Class 7 Clean Room Bay 3.
- .3 Installation of new mechanical and electrical infrastructure and pre-purchased equipment as detailed on drawings and specifications.
- .4 Perform work in accordance with Construction Schedule as outlined in this Section.
- .5 Work shall be phased in accordance with construction drawings & documents as to permit the operation of existing equipment serving adjacent space and decommissioning of AHU-8 (x).

1.2 MINIMUM STANDARDS

- .1 Materials shall be new and work shall conform to the minimum applicable standards of the Canadian General Standards Board, the Canadian Standards Association, the National Building Code of Canada 2015 (NBC) and all applicable Provincial and Municipal codes. In the case of conflict or discrepancy the most stringent requirements shall apply.

1.3 PRECEDENCE

- .1 For Federal Government projects, Division 1 Sections take precedence over technical specification sections in other Divisions of this Project Manual.

1.4 TAXES

- .1 Pay all taxes properly levied by law (including Federal, Provincial and Municipal).

1.5 FEES, PERMITS, AND CERTIFICATES

- .1 Pay all fees and obtain all permits with the exception of Building Permit. Provide authorities with plans and information for acceptance certificates. Provide inspection certificates as evidence that work conforms to requirements of Authority having jurisdiction.
- .2 Building Permit will be paid and provided by Departmental Representative.

1.6 FIRE SAFETY REQUIREMENTS

- .1 Comply with the National Building Code of Canada 2015 (NBC) for fire safety in construction and the National Fire Code of Canada 2015 (NFC) for fire prevention, firefighting and life safety in building in use.
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1.7 CONTRACT DOCUMENTS

- .1 Drawings and specifications are complementary, items shown or mentioned in one and not in the other are deemed to be included in the contract work.
- .2 The contract documents are intended to describe complete fully functional systems although not all components are indicated.
- .3 Discrepancies in the design documents, or doubt to the full intent of the design shall be brought to the Departmental Representative's attention prior to tender close. Failure to do this means, that the Contractor is fully aware and shall be responsible of design intent and requirements and shall provide fully functional and coordinated systems.

1.8 HAZARDOUS MATERIALS

- .1 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials; and regarding labelling and the provision of Material Safety Data Sheets (MSDS) acceptable to Human Resources Development Canada, Labour Program.
- .2 For work in occupied buildings give the Departmental Representative 48 hours' notice for work involving designated substances (Ontario Bill 208), hazardous substances (Canada Labour Code Part II Section 10)

1.9 WELDING AND CUTTING

- .1 At least 48 hours prior to commencing cutting or welding, provide to Departmental Representative:
 - .1 Completed hot work permit.
 - .2 Return hot work permit to Departmental Representative immediately upon completion of procedures for which permit was issued.
 - .3 A firewatcher shall be assigned when welding or cutting operations are carried out in areas where combustible materials within 10 m may be ignited by conduction or radiation. Fire watcher shall remain in area for a minimum period of one (1) hour following the completion of hot work.

1.10 FIELD QUALITY CONTROL

- .1 Carry out work using qualified licensed workers or apprentices in accordance with Provincial Act respecting manpower vocational training and qualifications.
- .2 Permit employees registered in Provincial apprenticeship program to perform specific tasks only if under direct supervision of qualified licensed workers.
- .3 Determine permitted activities and tasks by apprentices, based on level of training attended and demonstration of ability to perform specific duties.

1.11 TEMPORARY UTILITIES

- .1 Point of power supply for power will be supplied by the Departmental Representative at no cost to the contractor. The contractor shall provide equipment and labour to connect to power source and coordinate the use of existing services with Departmental Representative.
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1.12 STORAGE HANDLING OF MATERIALS INTENDED FOR REUSE

- .1 Store, materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.
- .2 Protect structural components not removed for demolition from movement or damage.
- .3 Support affected structures. If safety of building is endangered, cease operations and immediately notify Departmental Representative.
- .4 Protect architectural, mechanical and electrical systems from damage.
- .5 Separate and store materials produced during dismantling of structures in designated areas.

1.13 DISPOSAL OF WASTE

- .1 In accordance with all applicable codes, standards and regulations. Separate and divert materials to a recycling facility where possible.
- .2 Unless specified otherwise, materials for removal become Contractor's property and shall be taken from site.
- .3 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated facilities.
 - .1 On-site source separation is recommended.
 - .2 Remove co-mingled materials to off-site processing facility for separation.
- .4 Transport materials designated for disposal to waste processing sites.
- .5 Waste disposal bins shall be emptied by contractor prior to filling of bin to maximum permitted capacity. Contractor shall arrange for & dispose of contents of bins within 24 hours of notice by departmental representative should departmental representative deem bins unsafe or untidy.

1.14 PROTECTION

- .1 Protect and seal adjacent work to prevent the spread of dust and dirt for the protection of workers, finished areas of work and adjacent laboratory facilities beyond the work areas.
 - .2 Protect finished work against damage until take-over.
 - .3 Protect all floor areas in mechanical room with layer of the following:
 - .1 Flexible foam under pad
 - .2 Oriented standard board (minimum 6mm thick)
 - .4 Protect all floor areas in clean rooms and other areas with the following:
 - .1 Wipe clean from any debris or dust particles.
 - .2 Provide minimum 3.2mm thick foam layer on entire area to be protected.
 - .3 Provide 12mm plywood sheets on top of foam layer and tape all seams with duct tape to prevent debris and dust from getting trapped under the floor protection. Use of OSB sheets is not permitted.
 - .5 Areas used for access to construction site as a means of travel or for demolition shall be protected in similar fashion as mechanical room floor to prevent damage of floor surface.
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- .6 Protect operatives and other users of site from all hazards.

1.15 HOARDING

- .1 Erect temporary site enclosure around work site in mechanical room & around perimeter of waste disposal bin.
- .2 Hoarding to be in full compliance with requirements of the Ontario Health and Safety Act and Regulations - 1990 (OSHA)
 - .1 In accordance with OSHA, where required, provide 1.8m high sturdy fence to protect personnel from hazards.
- .3 Keep site fenced off at all times from general public. Only remove portion of fence to provide opening to site to accommodate access, minimize duration of opening, and immediately close when not required.
- .4 Ensure site is fully enclosed when work force is not on site.
- .5 Continually monitor condition of hoarding and make good repairs.
- .6 Provide temporary hoarding in corridors during delivery of materials & removal of

waste.

1.16 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .3 Make arrangements with and obtain permits from Authorities Having Jurisdiction for disposal of waste and debris.
- .4 Provide on-site dump containers for collection of waste materials and debris.
- .5 Provide and use marked separate bins for recycling.
- .6 Dispose of waste materials and debris at off site.
- .7 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .8 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .9 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .10 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.17 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
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- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Remove waste products and debris including that caused by other Contractors.
- .4 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .5 Make arrangements with and obtain permits from Authorities Having Jurisdiction for disposal of waste and debris.
- .6 Clean hardware and mechanical and electrical fixtures.
- .7 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, walls, and floors.
- .8 Vacuum clean and dust building interiors, behind grilles, louvers, screens, tops of roll up drum louvers, beams, and open web steel joist.
- .9 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .10 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds affected by work.
- .11 Sweep and wash clean paved areas.
- .12 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .13 Upon completion remove temporary protection and surplus materials. Make good defects noted at this stage.

1.18 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to the normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access, including emergency vehicles.
- .3 Maintain vehicle and pedestrian access, including emergency vehicles to and from the site.
- .4 Where security is reduced by work provide temporary means to maintain security.

1.19 SANITARY FACILITIES

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take precautions as required by local health authorities. Keep area free and premises in sanitary condition.
- .3 Portable facility shall be outside in a secured area covered by hoarding in a location approved by Departmental Representative.

1.20 SITE STORAGE

- .1 Storage and stockpile areas shall be equipped and maintained by the contractor.
 - .1 Storage and stockpile areas are to be contained entirely within the laydown/work area indicated.
 - .2 Contractor employee parking shall be contained within the indicated laydown/work area.
- .2 Do not unreasonably encumber site with materials or equipment.
- .3 Move stored products or equipment, which interfere with operations of Departmental Representative or other contractors.
- .4 Obtain and pay for use of additional storage or work areas needed for operations.

1.21 CUT, PATCH AND MAKE GOOD

- .1 Cut existing surfaces as required to accommodate new work.
- .2 Remove all items so shown or specified.
- .3 Patch and make good surfaces cut, damaged or disturbed, to Departmental Representative's approval. Match existing material, colour, finish and texture.

1.22 EXAMINATION

- .1 Examine site and conditions which will affect the work. Submission of tender shall be deemed as confirmation that tenderer has inspected site and is conversant with conditions, and shall not constitute additional costs as a result of site conditions.
- .2 Verify existing conditions including but not limited to, structural elements, sprinkler piping and heads, roof drains and storm piping, electrical conduit and wiring, process utility piping, ductwork and other building services.
- .3 The fact that not all existing conditions discussed in Item .2 above are shown on the drawings does not relieve the responsibility of coordinating the work with the existing construction.

1.23 SIGNS

- .1 Provide common-use signs related to traffic control, information, use of equipment, construction public safety devices, etcetera, in both official languages or by the use of commonly understood graphic symbols to the Department Representative's approval.

1.24 ACCESS AND EGRESS

- .1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.25 RECORDS

- .1 As work progresses, maintain accurate records to show deviations from contract drawings. Just prior to Departmental Representative's inspection for issuance of final certificate of completion, supply to the Departmental Representative one (1) set of white prints with all deviations neatly inked in, maintaining separate colours for each major
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system. In addition, provide a complete colour scan of said final marked up drawings and submit each drawing in electronic PDF format to the Departmental Representative. The Departmental Representative will provide one set of clean white prints for this purpose.

- .2 Drawings are to be updated at the end of each work period.
 - .1 Drawings are to be submitted for review by the Departmental Representative at the regularly scheduled construction project meetings.
 - .2 Store drawings on site in a clean dry area.
- .3 Make drawings available for review when requested by Departmental Representative.
- .4 Specifications: Mark each item to record actual construction including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed.
 - .2 Changes made by Addenda and Change Orders.

1.26 GUARANTEES AND WARRANTIES

- .1 Before completion of work collect all manufacturer's guarantees and warranties and deposit with Departmental Representative.

1.27 BUILDING SMOKING ENVIRONMENT

- .1 Smoking is not permitted in the Building. Obey smoking restrictions on building property.

1.28 TESTING LABORATORY SERVICES

- .1 Departmental Representative will appoint and pay for costs of inspection and testing services, unless indicated otherwise.
- .2 Provide safe working areas and assist with testing procedures, including provisions for materials or services and co-ordination, as required by testing agency and as authorized by Departmental Representative.
- .3 Where tests indicate non-compliance with specifications, contractor to pay for initial test and subsequent testing of work to verify acceptability of corrected work.

1.29 STAGING PLAN

- .1 Submit to Departmental Representative for review and approval, a staging plan that outlines work stages in compliance with specified implementation restrictions and in accordance with submitted schedule. Once approved by the Departmental Representative, do not make changes to specified stages without prior written approval of Departmental Representative. Any proposed changes to the Phasing Plan will require a minimum of 7 days advanced notice. Do not work in staging areas outside of indicated times.

1.30 TRAFFIC MANAGEMENT PLAN

- .1 Access to building will be through CRC campus Main Gate.
 - .2 Access to interior of David Florida Laboratory will be through stair G
 - .3 Access for equipment & tools will be through Large Loading Dock.
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1.31 CONSTRUCTION SCHEDULE

- .1 On award of contract submit to Departmental Representative within five (5) working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.
 - .2 Submit Project Schedule to Departmental Representative within five (5) working days of receipt of acceptance of Master Plan.
 - .1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).
 - .3 Departmental Representative will review and return revised schedules within five (5) working days.
 - .1 Revise impractical schedule and resubmit within five (5) working days.
 - .4 Accepted revised schedule will become Master Plan and be used as baseline for updates.
 - .5 Develop detailed Project Schedule derived from Master Plan.
 - .6 When schedule has been reviewed by the Departmental Representative, take necessary measure to complete work within scheduled time. Any changes to schedule following approval must be authorized by the Departmental Representative.
 - .7 Carry out work during "regular hour" Monday to Friday from 07:00 to 18:00 hours, unless otherwise indicated or required to meet project schedule.
 - .8 Carry out the following work during "silent hours", as defined as Monday to Friday from 18:00 to 07:00 hours and anytime on Saturdays, Sundays, and statutory holidays:
 - .1 To meet project schedule.
 - .2 For building service interruptions, provide at least seventy-two (72) hours' notice.
 - .9 All building operations in areas not under construction must be maintained during all phases of construction.
 - .10 Contractor to submit a written notice to the Departmental Representative with a minimum of seventy-two (72) hours' notice for work to be carried out during "silent hours", including the number, names of employees, name(s) of company(ies) and dates and times required for access to site.
 - .11 Definitions:
 - .1 Construction Work Week: Monday to Sunday inclusive and define schedule calendar working days as part of Bar (GANTT) Chart submission.
 - .2 Construction Start: First day that Contractor will have access to site for construction activities.
 - .3 Construction Completion: Last day of construction access to site for Contractor, before which point, all construction activities including but not limited to erection, testing, commissioning, certification, painting, demolition, cleanup, etc. are to be completed.
 - .4 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
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- .5 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
 - .12 Requirements:
 - .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
 - .2 Plan to complete Work in accordance with prescribed milestones and time frame.
 - .3 Limit activity durations to maximum of approximately ten (10) working days, to allow for progress reporting.
 - .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of the essence in this contract.
 - .13 Project milestones form interim targets for Project Schedule:
 - .1 On site mobilization starting on Construction Start date.
 - .2 Phase I:
 - .1 Isolation, disconnection, removal and capping of ductwork and plumbing services within two (2) weeks of Construction Start.
 - .2 Assembly of new AHU-7 (supplied by Departmental Representative) in Mechanical Room M6.
 - .3 Completion of mechanical, electrical, controls, testing, commissioning and certification of AHU-7 performance.
 - .4 Contractor shall minimize shutdown of services associated with AHU-5 (E) mounted on roof, but serving adjacent Bay 2 and Anechoic Chamber. All work associated with plumbing and ductwork serving, or affecting AHU-5(E) from operating shall be planned and coordinated to ensure that AHU-5(E) has ability to heat with maximum 24 shut down window. Coordinate schedule of shutdowns with Departmental Representative.
 - .3 Work between Phase I and Phase II:
 - .1 Testing and commissioning (duration of fifteen (15) consecutive days) prior start of Phase II.
 - .4 Phase II:
 - .1 Decommissioning and removal of AHU-8 (X) in Mechanical Room M6 c/w isolation, disconnection, removal of associated ductwork and capping of plumbing services serving units.
 - .2 Assembly of AHU-8 (N) (supplied by Departmental Representative).
 - .3 Completion of mechanical, electrical, controls, testing, commissioning and certification of AHU-8 performance.
 - .4 Testing and commissioning (duration of fifteen (15) consecutive days) five (5) weeks prior to Construction Completion date.
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- .5 Construction Completion and turnover to Departmental Representative including cleanup prior to Construction Completion date.
 - .14 Project schedule:
 - .1 Develop detailed Project Schedule derived from Master Plan.
 - .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
 - .1 Award.
 - .2 Shop drawings.
 - .3 Permits.
 - .4 Mobilization.
 - .5 Phase 1:
 - .1 Electrical disconnection.
 - .2 Supplied equipment long delivery items.
 - .3 Construction of new ductwork.
 - .4 Construction of new AHU-7.
 - .5 Electrical new work.
 - .6 Mechanical new work.
 - .7 Demolition and reinstatement of affected services.
 - .8 Controls.
 - .9 Commissioning of controls system.
 - .6 Work between Phase 1 and Phase 2:
 - .1 Testing and commissioning (duration of fifteen (15) consecutive days) prior to start of Phase 2.
 - .7 Phase 2:
 - .1 Protection of Bay 3. Demolition and modifications of ductwork and provision of new ductwork in Bay 3.
 - .2 Electrical disconnection.
 - .3 Demolition of existing units and services.
 - .4 Supplied equipment long delivery items.
 - .5 Construction of new ductwork.
 - .6 Construction of new AHU-8.
 - .7 Electrical new work.
 - .8 Mechanical new work.
 - .9 Demolition and reinstatement of affected services.
 - .10 Controls.
 - .8 Testing, commissioning and certification.
 - .9 Correction of deficiencies.
 - .10 Cleanup.
 - .11 Testing, and commissioning.
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- .12 Turnover of site to Departmental Representative.
- .13 Demonstration and training for Departmental Representative's personnel.
- .14 Operational & maintenance manual submittals, etc.
- .3 Allow in schedule for review of shop drawing submissions by departmental representative.
- .15 Project schedule reporting:
 - .1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress. Submit updated schedule to department representative weekly.
 - .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.
- .16 Project meetings:
 - .1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule. Contractor shall allow for weekly construction meetings. Department Representative shall determine if weekly or bi-weekly construction meetings shall be required during specific durations of the project.

1.32 COST BREAKDOWN

- .1 Before submitting first progress claim and within one (1) week of award of contract, submit breakdown of Contract Amount in detail. Indicate material and labour costs separately for Division and system. After acceptance by Departmental Representative, cost breakdown will be used as the basis of progress payments.
- .2 After acceptance by Departmental Representative, cost breakdown will be used as the basis of progress payments.

1.33 SUBMITTAL PROCEDURE

- .1 General:
 - .1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
 - .2 Do not proceed with Work affected by submittal until review is complete.
 - .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
 - .4 Where items or information is not produced in SI Metric units converted values are acceptable.
 - .5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed,
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- dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
 - .7 Verify field measurements and affected adjacent Work are co-ordinated.
 - .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.
 - .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.
 - .10 Keep one reviewed copy of each submission on site.
 - .11 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
 - .12 Shop drawings for structural support of air handling unit to be stamped and signed by professional engineer licensed in the Province of Ontario.
 - .13 Submit the shop drawings for the following items:
 - .1 Electrical breakers,
 - .2 Ductwork including flange connections,
 - .3 Fire Dampers,
 - .4 Balancing, splitter damper details,
 - .5 Flexible ductwork and piping connections,
 - .6 All valves including PRV,
 - .7 Ductwork Silencers,
 - .8 Ductwork Dampers,
 - .9 Piping materials,
 - .10 Any mechanical piping joint systems,
 - .11 Seismic Support Details,
 - .12 Louvers,
 - .13 Thermal Insulation and Jacketing,
 - .14 Thermometers and pressure gauges,
 - .15 Support details,
 - .16 System Identification,
 - .17 Controls shop drawings including points list, sequences of operation, system architecture, components and actuators, etc.
 - .2 Shop drawings and product data:
 - .1 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
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- .2 Allow five (5) working days for Departmental Representative's review of each submission.
 - .1 Allow ten (10) working days for Departmental Representative's review when large quantities of shop drawings are submitted.
 - .3 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
 - .4 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
 - .5 Accompany submissions with transmittal letter, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
 - .6 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying review and approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 General arrangement drawings, showing component parts, dimensions, including identified field dimensions, and operating and maintenance clearance ie. access door swing spaces.
 - .3 Setting or erection details.
 - .4 Mounting details and dimensions.
 - .5 Capacities.
 - .6 Complete certified performance data for the specified application, with particular reference to rate of flow, operating pressure and temperatures, entering and leaving conditions of air or fluid, operating limitation, electrical characteristics etc.
 - .7 Standards.
 - .8 Operating weight.
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- .9 Electrical wiring diagrams, control panel boards, motor test data, motor starters and controls for electrically-operated equipment furnished by mechanical trades.
 - .10 Single line and schematic diagrams.
 - .11 Relationship to adjacent work.
 - .12 Finish.
 - .13 Gauge of materials.
 - .14 Vibration isolators and resilient hangers stating locations and weight distribution.
 - .6 After Departmental Representative's review, distribute copies.
 - .7 Submit single electronic format (pdf) of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request. Reviewed shop drawings will be returned to contractor.
 - .8 Submit single electronic format (pdf) of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
 - .9 Submit single electronic format (pdf) of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .10 Submit single electronic format (pdf) of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
 - .11 Submit single electronic format (pdf) copies of manufacturer's instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
 - .12 Submit single electronic format (pdf) copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
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- .13 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
 - .14 Delete information not applicable to project.
 - .15 Supplement standard information to provide details applicable to project.
 - .16 Following review, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
 - .17 The review of shop drawings by the Departmental Representative is for sole purpose of ascertaining conformance with general design concept.
 - .1 This review shall not mean that Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
 - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.
 - .3 Material safety data sheets (MSDS):
 - .1 Submit Material Safety Data Sheets (MSDS) for the following products. Indicate VOC emissions, prior to installation or use:
 - .1 Adhesives, caulking sealing, fireproofing or fire stopping compounds, paints, floor and wall patching or levelling materials, lubricants.
 - .2 MSDS to comply with Occupational Health and Safety requirements.
 - .4 Certificates and transcripts:
 - .1 Immediately after award of Contract, submit Workers' Compensation Board status.
 - .5 Operation and maintenance instructions manuals:
 - .1 Submit single hard copy of draft Operation and Maintenance Instruction Manual to Departmental Representative for approval, compiled in the following format:
 - .1 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets. Project name and number must appear on binder face and spine.
 - .2 Cover: identify each binder with type or printed title "Operation and Maintenance Instructions".
 - .3 Title Sheet:
 - .1 Labelled "Operation and Maintenance Instructions".
 - .2 Date of submission; names.
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- .3 Name of project.
 - .4 Addresses, and telephone numbers of Contractor with name of responsible parties.
 - .5 Schedule of products and system, indexed to content of volume.
 - .4 Organize contents as instructional manual into applicable sections of work to parallel project specifications breakdown. Mark each section by labelled tabs protected with celluloid covers fastened to hard paper dividing sheets.
 - .5 Drawings: provide with reinforced punched binder tab.
 - .1 Bind in with text; fold larger drawings to size of text pages.
 - .6 When multiple binders are used correlate data into related consistent groupings.
 - .1 Identify contents of each binder on spine.
 - .7 Information in manuals is to be specific to this project. Generic information is unacceptable.
 - .2 Include the following information plus data specified:
 - .1 Installation and maintenance instructions for equipment and materials.
 - .2 Description: Operation of the equipment and systems defining start-up, shut-down and emergency procedures, and any fixed or adjustable set points that affect the equipment operation. Include nameplate information such as make, size and serial number. Include appropriate wiring diagrams, schematics, elevations, mounting requirements, options included, etc. as it pertains to each system and/or device.
 - .3 Maintenance: Use clear drawings, diagrams or manufacturers' literature which specifically apply and details the following:
 - .1 Lubrication products and schedules.
 - .2 Trouble-shooting procedures.
 - .3 Adjustment techniques.
 - .4 Operational checks. Supplier names with addresses and telephone numbers of points of contact; components supplied by them must be included in this section. Components must be identified by a description and manufacturer's part number.
 - .4 Spare Parts: List all recommended spares to be maintained on site to ensure optimum efficiency. List all special tools appropriate for unique application. All parts/tools detailed must be identified as to manufacturer, part number and supplier.
 - .5 Shop Drawings: Include final complete reviewed set of shop drawings with all mark-ups, comments, and Contractor's and Departmental Representative's stamps. Indicate any changes made during fabrication and installation.
 - .6 As Built Documents: Include all final marked up Contract Drawings indicating any deviation from design including Addenda, Change Orders and other modifications to Contract.
 - .7 For each product or system:
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- .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .8 Guarantees and Warranties in accordance with Section 01 78 00 – Closeout Submittals.
 - .9 Material Safety Data Sheets (MSDS).
 - .10 Control Contractor's Pre Start-up, Start-up, Commissioning & Testing Field Reports.
 - .11 Inspection Certificates.
 - .12 Manufacturers' Certificates.
 - .13 Training: refer to Section 21 05 01 – Common Work Results for Mechanical.
- .3 Within four (4) weeks of acceptance of draft manuals by Departmental Representative submit single electronic format (pdf) and three (3) sets of hard copies of Operation and Maintenance Instruction Manuals.

1.34 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store sheet materials on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .5 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .6 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .7 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.35 TRANSPORTATION

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Departmental Representative will be paid for by Departmental Representative. Unload, handle and store such products.

1.36 MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise indicated in specifications install or erect projects in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
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- .2 Notify Departmental Representative in wiring, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative will establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and reinstallation at no increase in Contract Price or Contract Time.

1.37 QUALITY OF WORK

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.38 COORDINATION

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.
- .3 Coordinate the Work with all other Divisions, to ensure system compatibility, and to ensure schedules and requirements are maintained.
- .4 Where perceived interferences occur, prepare detailed sketches indicating proposed solution for review and acceptance by Departmental Representative.

1.39 CONCEALMENT

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

1.40 FINAL INSPECTION

- .1 Do not request final inspection until:
 - .1 Deficiencies are less than twenty-five (25) items.
 - .2 All systems have been tested and are ready for operation.
 - .3 All air and water balancing has been completed, as applicable.
 - .4 The Departmental Representative's operating personnel have been instructed in the operation of all systems and equipment.
 - .5 The complete operation and maintenance data books have been delivered to the Departmental Representative.
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- .6 All inspection certificates have been furnished including but not limited to seismic certification, City's final plumbing inspection.
 - .7 All record drawings have been completed and approved.
 - .8 All fire extinguishers have been installed.
 - .9 All spare parts and replacement parts have been provided and receipt of same acknowledged.
 - .10 The cleaning up is finished in all respects.
 - .11 Upon completion of above, the Contractor is to request in writing for final site review with a minimal seventy-two (72)-hour notification.
- .2 Final installation shall be subject to the approval of the Departmental Representative.

1.41 REMEDIAL WORK

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Neither perform in a manner to damage nor put at risk any portion of Work.

1.42 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .4 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .5 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.43 FASTENING – EQUIPMENT

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.44 PROTECTION OF WORK IN PROGRESS

- .1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Departmental Representative.
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1.45 EXISTING UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at time directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants. Coordinate all Work affecting services of utilities in areas not under construction with Departmental Representative.
- .2 Protect, and maintain existing active services.

1.46 GENERAL CAMPUS PROCEDURES

- .1 Access & Security
 - .1 Contractors must sign-in to receive an access badge at the guardhouse. Valid Photo ID is required.
 - .2 Contractors must sign-in at DFL contractor's electronic station or on-site project log-book.
 - .3 Badges must be worn visibly at all time; all lost badges must be reported immediately to DFL Commissionaire for notification to the guardhouse.
 - .4 Contractors must be escorted at ALL times by either a DFL Commissionaire or cleared DFL personnel responsible for the contractor.
 - .5 Normal working hours are Monday to Friday - from 07:00am to 3:30pm. Any hours outside that range are considered as 'after-hours / silent hours' and must require minimum of full 3 working day's notification with the names of all workers to be provided to the DFL project manager.
 - .6 Parking spots for contractor and all his sub-contractors to be designated by DFL project manager, all illegal parking will be ticketed by campus security.
 - .7 Careful attention must be paid to posted speed limits. RCMP is active on the campus and will issue tickets for speeding.
 - .2 Site Facilities
 - .1 No large storage available on site, storage of small items must have previous arrangement in place.
 - .2 Construction activities must remain within the predefined boundaries unless otherwise permitted in writing.
 - .3 Do not block campus roads or parking spots at any time. Moving & operation of all heavy machinery, lifts or cranes for construction or deliveries must be coordinated and approved by DFL project manager at a minimum of full 2 working days' notice.
 - .4 Do not dump any hazardous materials or any kind of contamination in campus drains or manholes, report any equipment fuel or hydraulic oil leaks immediately to DFL project manager. Any leaks to be immediately contained & cleaned in a proper and legal manners.
 - .5 Contractor to be responsible for any damages to campus roads, sidewalks, pavement, lawns, trees, plans, signs, light / camera posts... etc. resulting from all project's work. The contractor shall fix & make good all damaged surfaces. All new & remedial work within construction area should be equal or better condition than it was before starting construction and subject to CSA & campus approvals, all at no additional cost to CSA or campus.
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- .3 Communication & Photography
 - .1 Phone at the Commissionaire's station or DFL basement is permitted for use.
 - .2 No cell phones will be permitted on site.
 - .3 No cameras permitted on site; any requirement for pictures will come as a request to Department Representative.
- .4 Hot Work Permits
 - .1 Any work that will create smoke, dust or heat must be coordinated at a minimum of three full working days in advance to DFL Project Manager for the issuance of a hot work permit, for each day required.
- .5 Workmanship & Ethics
- .6 Cleanliness is of the utmost importance; it is expected that construction cleanup will be at the end of each day.
- .7 Foul language or improper behavior will not be tolerated.
- .8 Proper building and site protection must be provided at all times.
- .9 Health and Safety practices must be strictly observed on site at all times.

1.47 DFL ARCHITECTURAL STANDARDS

- .1 General Architectural & partition notes
 - .1 All materials and workmanship shall - as a minimum - be in accordance with the latest edition of the following:
 - .1 National Building Code - NBC,
 - .2 Ontario Building Code - OBC,
 - .3 Ontario fire code, NFPA-13 & ASHRAE 90.1
 - .4 All other applicable provincial, municipal and safety codes and regulations.
 - .2 Core drill / cut concrete and metal floors as required permitting installation of all new services as per drawings and owner instructions & requests. Patch & infill abandoned & unused holes with high strength non-shrink grout and reinforce with wire mesh as required.
 - .3 Contractor to protect all architectural finishes & flooring during construction, be responsible for any damages to existing surfaces resulting from all project's work. The contractor shall make good all damaged surfaces including any paint touch-ups required. Repair all walls, floors & ceilings in core area where mechanical & electrical services pass through.
 - .4 Unless noted otherwise, all dimensions shown are from finished faces to finished face of walls, ceilings and other surfaces as referred. Dimensions indicated as clear dimensions shall be from finished surfaces.
 - .5 Engineer to approve layout of partitions prior to construction (chalk line)
 - .6 Unless noted otherwise, carry over the same partition details over door openings and sidelight openings. brace walls and door frames as required to u/s of structural deck and/or suspended ceilings
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- .7 All new partitions at exterior windows shall clear window frame and shall be finished from all sides using drywall "J" trim.
- .8 Unless indicated otherwise, all doors to be located 6" from the adjacent wall face to inside of hinged door jamb.
- .9 Use ROXUL-AFB batt insulation on all interior drywall insulated partition, thickness to match framing.
- .10 Use dust control drywall compound on final coat.
- .11 Contractor to provide all necessary and required blocking in wall and ceiling where heavy loading is anticipated. These blocking and reinforcements may not be shown on drawings and details. All reinforcements in ceiling plenum areas shall be of non-combustible and shall not generate airborne particles.
- .12 Contractor to provide complete system of equipment supports / anchors in accordance with MSS SP-58 and MSS SP-69 and to match existing building supports. Use of C-clamps on beams is not permitted, use beam clamp to support all threaded rods.
- .13 Provide -as minimum- 300mmx300mm access doors to all recessed plumbing, HVAC, fire & electric fixtures.
- .14 Apply smooth bead of latex paintable caulking as required for any architectural finishes and to door frames, millwork, countertops, trims, moldings, floor base, T-bar wall trims ... etc. color to match finishes.
- .15 Contractor shall remove all protective materials and to have professional cleaning service to clean and wipe down all equipment, windows, doors, walls, floors, ceilings & millwork upon completion.
- .16 Provide as-built drawings in both AutoCAD (DWG) and PDF formats to record any deviations from the design intent drawings.

1.48 DFL CLEAN ROOM PROCEDURES

- .1 Cleanroom Regulations and Clothing Requirements
 1. Clean Rooms are all areas within the air showered rooms, except the loading dock(s) and change rooms.
 2. All other areas are not considered as "Clean Rooms".
 3. When working within the clean room(s), all personnel shall:
 1. Wear a clean room coat (cloth or disposable), completely fastened.
 2. Wear a disposable head / beard cap ensuring all hair is covered by the cap.
 3. Ensure footwear is clean.
 4. Attire not approved in clean rooms include shorts, skirts, dresses, open shoes (sandals, flip-flops, etc.), high heel shoes are not preferred for safety and protection of floor finishes.
 - .2 Clean Room Entry & Exit Procedures
 1. Personnel must remove all weather protection clothing (coats, boots etc.) prior to entering any clean room.
 2. Shoes must be cleaned using the shoe cleaner.
 - a. *NOTE:* Shoe cleaners are not intended for use on heavily soiled footwear
 3. All personnel must use the air shower prior to entering the change room.
 4. Personnel must walk on the sticky mats prior to entering the clean room.
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5. Exit from any clean room will be either through the air shower (which does not operate on exit), or via direct exit door.
- .3 Working Within the Clean Rooms
 - .1 Any drilling, cutting, grinding, filing or other jobs creating swarf or debris must be done with a HEPA vacuum running at all times to collect all debris generated.
 - .2 All equipment, materials, lifts or cranes brought into the clean room from the outside must be thoroughly cleaned prior to entry and clear of any dust, mud or loose particles.
- .4 Clean Room Containers
 - .1 Containers must be constructed from metal, plastic or smoothly finished wood, and must be sealed with urethane or oil-based paint.
 - .2 Insulation, either fixed or removable must be sealed to prevent shedding.
 - .3 Containers brought into the clean room from the outside must be thoroughly cleaned prior to entry and completely wrapped in new clean plastic or cling film.
 - .4 NO cardboard boxes or bare wood are permitted in the clean rooms.
 - .5 Interior loading dock doors must not be opened while the exterior loading dock door is open.
- .5 Prohibited Clean Room Practices
 - .1 Wearing clean room clothing outside designated clean rooms and controlled areas.
 - .2 Wearing street clothes in designated clean rooms and controlled areas.
 - .3 Grooming, eating, drinking or smoking within any designated clean room or controlled area.
 - .4 Painting or leaving chemical containers and contaminants open or exposed in any designated clean room or controlled area.
 - .5 No radios or music is allowed in clean rooms and controlled areas.
 - .6 Cameras and photos are totally prohibited in clean rooms and controlled areas.
 - .7 Failing to clean job sites at the completion of a job or at the end of a shift.
 - .8 ADMITTING UNAUTHORIZED PERSONNEL INTO THE DFL SECURED AREAS WITHOUT AUTHORIZATION.

Part 2 Products

2.1 NOT USED

- .1 Not Used

Part 3 Execution

3.1 NOT USED

- .1 Not Used

Part 1 General

1.1 COMPLIANCE REQUIREMENTS

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .3 Occupational Health and Safety Act, R.S.O. 1990
- .4 CAN3-Z166.2 – Use and Handling of Powder Actuated Tools.

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 00 10 – General Instructions and Section 01 78 00 – Closeout Submittals.
- .2 Submit site-specific Health and Safety Plan: Within seven (7) days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .4 Submit copies of incident and accident reports.
- .5 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 00 10 – General Instructions.
- .6 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.

1.3 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.

1.4 GENERAL REQUIREMENTS

- .1 Provide site specific safety hazard assessment related to project.
- .2 Work at site will involve exposure to elevated heights (up to 22 meters).
- .3 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .4 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns

1.5 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be
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affected by conduct of Work.

- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.
- .3 Provide full time supervision for duration of Work.
- .4 Complete Health and Safety Training Sessions and ensure that personnel not successfully completing required training are not permitted to enter site to perform Work.

1.6 UNFORSEEN HAZARDS

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative verbally and in writing.

1.7 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Departmental Representative.

1.8 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.
- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.9 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Departmental Representative and if so, comply with requirements of CAN3-Z166.2 – Use and Handling of Powder Actuated Tools.

1.10 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 NOT USED

- .1 Not Used
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|---------------|------------------|
| Part 3 | Execution |
| 3.1 | NOT USED |
| .1 | Not Used |

Part 1 General

1.1 REFERENCES AND CODES

- .1 Perform Work in accordance with National Building Code of Canada (NBC) including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.2 HAZARDOUS MATERIAL DISCOVERY

- .1 Asbestos: demolition of spray or trowel-applied asbestos is hazardous to health. Stop work immediately when material resembling spray or trowel-applied asbestos is encountered during demolition work. Notify Departmental Representative.
- .2 PCB: Polychlorinated Biphenyl: stop work immediately when material resembling Polychlorinated Biphenyl is encountered during demolition work. Notify Departmental Representative.
- .3 Mould: stop work immediately when material resembling mould is encountered during demolition work. Notify Departmental Representative.

1.3 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions and municipal by-laws.

Part 1 Products

1.1 NOT USED

- .1 Not Used

Part 2 Execution

2.1 NOT USED

- .1 Not Used

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-warranty Meeting:
 - .1 Convene meeting one (1) week prior to contract completion with Contractor's representative to:
 - .1 Verify Project requirements.
 - .2 Review manufacturer's installation instructions and warranty requirements.
 - .2 Departmental Representative to establish communication procedures for:
 - .1 Notifying construction warranty defects.
 - .2 Determine priorities for type of defects.
 - .3 Determine reasonable response time. Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.
 - .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 – General Instructions.
- .2 One (1) week prior to Substantial Performance of the Work, submit to the Departmental Representative, draft copy of Operation and Maintenance Instruction Manuals in English.
- .3 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 AS -BUILT DOCUMENTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
 - .2 Store record documents and samples in field office apart from documents used for construction.
 - .1 Provide files, racks, and secure storage.
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- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
 - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition.
 - .1 Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.

1.4 EQUIPMENT AND SYSTEMS

- .1 For each item of equipment and each system include description of unit or system, and component parts.
 - .1 Give function, normal operation characteristics and limiting conditions.
 - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
 - .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
 - .3 Include installed colour coded wiring diagrams.
 - .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
 - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
 - .2 Include summer, winter, and any special operating instructions.
 - .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - .6 Provide servicing and lubrication schedule, and list of lubricants required.
 - .7 Include manufacturer's printed operation and maintenance instructions.
 - .8 Include sequence of operation by controls manufacturer.
 - .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
 - .10 Provide installed control diagrams by controls manufacturer.
 - .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
 - .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
 - .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
 - .14 Include test and reports as specified in Section 01 00 10 – General Instructions and Section 21 05 01 – Common Work Results for Mechanical.
 - .15 Additional requirements: as specified in individual specification Sections.
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1.5 MATERIALS AND FINISHES

- .1 Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Additional requirements: as specified in individual specifications Sections.

1.6 MAINTENANCE MATERIALS

- .1 Special Tools:
 - .1 Provide a single set of special tools, for unique application required to perform maintenance on equipment provided or installed.
 - .2 Provide items with tags identifying their associated function and equipment.
 - .3 Deliver to site; place and turn over to Departmental Representative.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Departmental Representative.
 - .2 Include approved listings in Maintenance Manual.

1.7 GUARENTEES AND WARRANTIES

- .1 Develop warranty management plan to contain information relevant to Warranties.
 - .2 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.
 - .3 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel, including roles and responsibilities of personnel associated with warranty process, indicating points of contact and telephone number within the organization of Contractors, sub-contractors, manufacturers and/or suppliers involved.
 - .4 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
 - .1 Leave date of beginning of time of warranty until Date of Substantial Performance is determined.
 - .5 Collect all manufacturers' guarantees and warranties. Contractor to submit a written signed guarantee stating that all systems and components have been installed to manufacturers' recommendations and that systems are operating satisfactorily and meet the design requirements, and all material and labour deficiencies will be corrected, at no cost, for a period of one year after substantial completion date.
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- .6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
 - .1 Separate each warranty with index tab sheets keyed to Table of Contents listing.
 - .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .3 Obtain warranties, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten (10) days after completion of applicable item of work.
 - .4 Verify that documents are in proper form, contain full information, and are notarized.
 - .5 Co-execute submittals when required.
 - .6 Retain warranties until time specified for submittal.
- .7 Conduct joint six (6) month and twelve (12) month warranty inspection, measured from time of acceptance, by Departmental Representative.
- .8 Respond in timely manner to oral or written notification of required construction warranty repair work.
- .9 Written verification to follow oral instructions.
 - .1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 05 – Installation of Pipework.
- .2 Section 23 31 13 – Metal Ducts.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 ULC-S115-2005, Fire Tests of Fire stop Systems.

1.3 DEFINITIONS

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted; (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): penetrating items that are cast in place in buildings of non-combustible construction or have "0" annular space in buildings of combustible construction.
 - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.4 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 – General Instructions.
- .2 Samples:
 - .1 Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for the project.

Part 2 Products

2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
-

- .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN- ULC-S115 and not to exceed opening sizes for which they are.
- .2 Fire stop system rating: FT.
- .3 Equal to 3M caulk CP25 and putty 303.
- .2 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .3 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .4 Sealants for vertical joints: non-sagging.

Part 3 Execution

3.1 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.2 INSTALLATION

- .1 Installation of fire stops by trained manufacturer's representative.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

3.3 SEQUENCES OF OPERATION

- .1 Proceed with installation only when submittals have been reviewed by the Departmental Representative.
 - .2 Mechanical pipe insulation: certified fire stop system component.
 - .1 Ensure pipe insulation installation precedes fire stopping.
-

3.4 FIELD QUALITY CONTROL

- .1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

3.5 SCHEDULE

- .1 Fire stop and smoke seal at:
 - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - .2 Top of fire-resistance rated masonry and gypsum board partitions.
 - .3 Intersection of fire-resistance rated masonry and gypsum board partitions.
 - .4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
 - .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
 - .6 Around mechanical and electrical assemblies penetrating fire separations.
 - .7 Mechanical Ducts: greater than 129 cm².
 - .1 Fire-stopping to be applied in accordance with fire damper manufacturer's instruction.

Part 1 General

1.1 DELIVERY STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 – General Instructions and with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
 - .1 Store gypsum board assemblies materials level off ground, indoors, under cover and in accordance with manufacturer's recommendations in clean, dry, well- ventilated area.
 - .2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.
 - .3 Protect from weather, elements and damage from construction operations.
 - .4 Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal accessories and trim from being bent or damaged.
 - .5 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 To match existing.

2.2 FINISHES

- .1 Texture finish: asbestos-free standard white texture coating, primer-sealer and two coats of paint recommended by gypsum board manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 ERECTION

- .1 Do application and finishing of gypsum board to ASTM C 840 except where specified otherwise.
 - .2 Do application of gypsum sheathing to ASTM C 1280.
 - .3 Install work level.
 - .4 Frame with furring channels.
-

- .5 Erect drywall resilient furring transversely across studs, spaced maximum 600 mm on centre and not more than 150 mm from ceiling/wall juncture. Secure to each support with 25 mm drywall screw.

3.3 APPLICATION

- .1 Apply single and double layer gypsum board to metal furring or framing using screw fasteners. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings prior to application of walls to ASTM C 840.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .2 Double-Layer Application:
 - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
 - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
 - .3 Apply base layers at right angles to supports unless otherwise indicated.
 - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.
- .2 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, in partitions where perimeter sealed with acoustic sealant.
- .3 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .4 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .5 Install gypsum board with face side out.
- .6 Do not install damaged or damp boards.
- .7 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.
 - .2 Install casing beads around perimeter of suspended ceilings.
 - .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
-

- .4 Splice corners and intersections together and secure to each member with 3 screws.
- .5 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .6 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWC Recommended Specification on Levels of Gypsum Board Finish
 - .1 Levels of finish:
 - .1 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges. Last coat to be dust control drywall compound to minimize spread of dust.
- .7 Finish corner beads and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .8 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .9 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .10 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
- .11 Mix joint compound slightly thinner than for joint taping.
- .12 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.
- .13 Allow skim coat to dry completely.
- .14 Remove ridges by light sanding or wiping with damp cloth.

3.5 CLEANING

- .1 In accordance with Section 01 00 10 – General Instructions.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

3.7 PAINTING

- .1 Colours:
 - .1 Departmental Representative will provide Colour Schedule after Contract award.
 - .2 Colour schedule will be based to match existing type and colour of paint in Bay.
 - .2 Interior painting and repainting:
 - .1 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock" type material, etc.
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- .2 INT 9.2A – minimum two coats latex, eggshell finish (sheen 18-00) (over latex primer).
 - .3 Protection:
 - .1 Protect exiting building surfaces and adjacent structures from paint splatters, markings, and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Departmental Representative.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames, windows, framing, lighting fixtures etc.
 - .3 Protect factory finished products and equipment.
 - .4 Surface Preparation:
 - .1 Place “WET PAINT” signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.
 - .2 Clean and prepare surfaces in accordance with MPI – Architectural Painting Specification Manual and MPI – Maintenance Re-Painting Manual specific requirements and coating manufacturer’s recommendations.
 - .1 Remove dust, dirt, and other surface debris by vacuuming and wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.
 - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
 - .6 Use trigger operated spray nozzles for water hoses.
 - .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water- based paints.
 - .3 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.
 - .4 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
 - .5 Touch up of shop primers with primer as specified.
 - .6 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.
 - .5 Application:
 - .1 Method of application to be as approved by Departmental Representative. Conform to manufacturer’s application instructions unless specified otherwise.
 - .2 Brush and Roller Application:
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- .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
- .2 Work paint into cracks, crevices and corners.
- .3 Paint surfaces and corners not accessible to brushing using spray, daubers and/or sheepskin. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
- .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
- .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Apply coats of paint continuous film of uniform thickness. Re-paint thin spots or bare areas before next coat of paint is applied.
- .4 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .5 Sand and dust between coats to remove visible defects.
- .6 Finish surfaces both above and below sight lines as specified for surrounding surfaces.

Part 1 General

1.1 GENERAL

- .1 This Section covers items common to all Sections of Division 21, 23, and 25.
- .2 Coordinate location and installation of all equipment with all trades to ensure the equipment with all trades to ensure the equipment is serviceable.
- .3 Prime mechanical contractor shall be responsible to ensure that all requirements of Division 21, 23, and 25 are met and comply with all other divisions and contract documents.
- .4 The word “provide” shall mean “supply and install”.

1.2 NOMINATION LIST

- .1 Complete Nomination List, Section 21 05 02 – Nomination List by adding the Subcontractor name and submit for approval.

1.3 CONTROLS WORK

- .1 Scope of work associated with the integration of new system and equipment with the existing building automation system by base building controls contractor, refer to specification section 25 90 01.
- .2 Contractor shall carry for the manufacturer testing, start-up and commissioning of AHU-7 and AHU-8 and all new controls systems.

1.4 EQUIPMENT LIST

- .1 Complete a list of equipment and materials to be used on this project and forming part of tender documents by adding Manufacturer’s name, model number and details of materials, and submit for approval.
- .2 Any costs associated with deviations of mechanical equipment electrical ratings affecting electrical Division 26 shall be carried by this contract.

1.5 EQUIPMENT INSTALLATION

- .1 Unions, flanges, and/or couplings: provide for ease of maintenance and disassembly.
 - .2 Space for servicing, disassembly, and removal of equipment and components: provide as recommended by the Manufacturer, Code or as indicated; whichever is the more stringent.
 - .3 Equipment drains: pipe to floor drains in a manner which non-obstructing or a trip hazard.
 - .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.
 - .5 Provide new materials and equipment of proven design, quality and of current models with published ratings for which replacement parts are readily available.
 - .6 Uniformity:
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- .1 Use product of one Manufacturer unless otherwise specified, for equipment or material of the same type of classification.
- .2 Installation:
 - .1 Unless otherwise specified, follow the Manufacturer's recommendations for safety, adequate access for inspection, maintenance and repairs.
 - .2 Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems without interference with building structure or other equipment.
- .3 Lubrication:
 - .1 Provide accessible lubricating means for bearings, including permanent lubrication "Lifetime" bearings. Extended grease nipples to be supplied.
- .7 AHU-7 & 8 (New):
 - .1 Erect and install unit on a flat surface level within 3mm and of sufficient strength to support the unit.
 - .2 Provide components furnished as per manufacturer's literature.
 - .3 Provide all water, steam and condensate piping so water circuits are serviceable, without having to dismantle excessive lengths of pipe.
 - .4 Provide valves in water piping upstream and downstream of each coil for isolating the coils for maintenance and to balance and trim the system. Install valves and accessories so that coils can be removed without excessive removal of control valves and services.
 - .5 Provide drain valves and vent cocks to each coil.
 - .6 Provide strainers ahead of all pumps and controls valves.
 - .7 Provide certified wiring schematics to the electrical division for the equipment and controls.
 - .8 Provide all necessary control wiring as recommended by the manufacturer and specified herein.
 - .9 Provide condensate traps in accordance with manufacturers recommendations.
 - .10 Insulate all piping c/w jacket where indicated.
 - .11 Provide ductwork connections to new unit c/w bypass ductwork. Provide flexible ductwork at all connections to new unit.
 - .12 Contractor shall provide for a complete and operable installation of the new units.

1.6 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts and templates for installation by other divisions.

1.7 TRIAL USAGE

- .1 Departmental Representative may use equipment and systems for test purposes or for continuity of operation prior to acceptance. Supply labour, material, and instruments required for testing and operation. Duration of testing will be fifteen (15) days.
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1.8 PROTECTION OF OPENINGS

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system. Provide temporary caps or same material as system to be protected. Filter media shall not be an acceptable means of system protection.

1.9 ELECTRICAL

- .1 Electrical work to conform to Division 26 including the following:
 - .1 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems. Refer to Division 26 for quality of materials and workmanship.
 - .2 Any costs associated with deviation of mechanical equipment rating affecting electrical Division 26 shall be carried by this contract.
 - .3 All control wiring and conduit associated with AHU-7 and AHU-8 controls shall be provided by Divisions 21, 23, and 25 including power wiring to all control panels, interconnection between the AHUs and other field-mounted control devices. Emergency power circuits are provided by Division 26 in the vicinity of the power source.
 - .4 All control wiring and conduit associated with Building Automation System and HVAC controls shall be provided by Divisions 21, 23, and 25 including power wiring to all control panels and other field-mounted control devices. Emergency power circuits are provided by Division 26 in the vicinity of the power source.

1.10 IDENTIFICATION AND NAMEPLATES

- .1 Nameplates shall be provided for all control items listed or shown approved control diagrams. Each inscription shall identify its function, such as “mixed air output transducer”, “cold deck sensor”, etc.
 - .2 All panels and items mounted on panel faces shall be identified by laminated plastic nameplates three 3 mm thick Melamine plastic white with black centre core. Surface shall be a matte finish. All corners shall be square. The lettering shall be accurately aligned and engraved into the white core. Size of nameplates shall be 25 mm by 67 mm minimum. Lettering shall be minimum 7 mm high normal black lettering.
 - .3 Field Sensors, Controlled Devices, and Interior Panel Components shall be identified by 5 cm x 10 cm plastic enclosed cards attached to the device by chain. Data to include: point name, schematic drawing designation number, model number, capillary length, size, range, set point, and other pertinent data. Print shall be 5 mm high and produced from a laser printer in dark black.
 - .4 Room sensing elements are to be similarly identified by stick on labels on the inside cover. The point name shall be displayed on the face of the cover by engraved or laminated nameplates.
 - .5 Submit samples of identification tags and lists of wording proposed to Departmental Representative for approval. Indicate character height and line thickness.
 - .6 All Controller and companion cabinet interior components must be labelled.
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1.11 WIRING AND IDENTIFICATION

- .1 In accordance with Section 26 05 00 – Common Work Results for Electrical
- .2 Provide numbered plastic ring markings on all branch control wiring.
- .3 Use colour-coded wires in communication cables, maintain colour coding throughout.
- .4 Identify all power sources at each panel location.

1.12 PREPARATION FOR FIRESTOPPING

- .1 Fire-stopping material and installation within annular space between pipes, ducts, insulation, and adjacent fire separation: specified in Section 07 84 00 – Fire Stopping.
- .2 Uninsulated, unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe to move without damaging fire-stopping material.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation

1.13 SPARE PARTS & SPECIAL TOOLS

- .1 Provide in accordance with Section 01 78 00 – Closeout Submittals.

1.14 SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 – General Instructions.
 - .2 One-line diagram from sensor and control points to Field Interface device and/or Terminal Control Unit including all components and cables.
 - .3 All instruments, control devices, attachments and accessories, complete with specifications and calibration details. Indicate controller and auxiliary control cabinet locations.
 - .4 Control diagrams, sequence for operations, and control logic for each controlled area.
 - .5 Complete the valve and actuator schedule listing including the following information:
 - .1 Designation
 - .2 Service
 - .3 Unit model
 - .4 Point I.D.
 - .5 Design flow
 - .6 Pressure drop
 - .7 Required CV
 - .8 Valve size
 - .9 Actual CV
 - .6 Show drawing for each input/output device, showing all information associated with each particular point including:
 - .1 Sensing element type and location
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- .2 Transmitter type and range
- .3 Details of associated field wiring schematics, schedules and termination's
- .4 Point address
- .5 Set points or curves or graphs and alarm limits (H + L, 3 types) and signal range
- .6 Manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter

1.15 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Instructions.
 - .1 Leave work area clean at end of each day.
 - .2 Final Cleaning:
 - .1 Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Instructions.

Prior to turnover to Departmental Representative, clean interior and exterior of all new systems. Replace all air and hydronic filters on new and modified systems. Vacuum interior of new and modified ductwork and air handling units.

1.16 CONFLICT/CO-ORDINATION DRAWINGS

- .1 For congested areas, prior to installation the Contractor shall prepare interference drawings indicating proposed location of all systems and equipment including ductwork, piping, fans, diffusers, conduits, lighting fixtures, etc. Prior to installation the Contractor shall submit the drawings to the Departmental Representative for review.
 - .1 At minimum provide conflict drawings for the following areas:
 - .1 Mechanical room M-6.
 - .2 Architectural, structural, and electrical outlines may be shown to assist in coordination of work; confirm final arrangements before layout of mechanical work.
 - .3 Do not scale.
 - .4 Except where dimensioned, drawings indicate general mechanical layouts only.
 - .5 Provide field drawings to show relative positions of various services. Obtain approval before beginning work. Drawings must show coordination between all equipment and systems within the given space. All sub-trades to coordinate their work in conjunction with others.
 - .6 Within two (2) weeks of Award of Contract, mechanical and electrical trades to verify that proposed rooms, shafts, chases, reflected ceiling elevations, etc. provide adequate space for the installation of mechanical and electrical systems. This is to identify if there are any spatial shortcomings and to give adequate time for the Departmental Representative and trades to make any dimensional changes and to make clear to all trades where items are to be installed. Installation and layout will not be on a first come first layout basis.
 - .7 If this procedure is not followed the Contractor shall be responsible for all modifications required to integrate the systems and equipment.
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1.17 LOCATION OF MECHANICAL EQUIPMENT

- .1 Allow for 1500 mm of adjustment for exact location of air handling units, ducts, piping, etc. at no extra cost or credit.

1.18 CUTTING, PATCHING, AND CORING

- .1 Provide cutting, patching and coring of all walls, ceiling and concrete slabs and other surfaces as required for mechanical work. Check with Departmental Representative prior to core drilling and cutting of structure regarding building requirements and policies. Provide notification, clearance, and protection.
- .2 The following procedure shall be followed for cutting and core drilling:
 - .1 The Contractor is to coordinate and summarize all new cores and openings in building structure. The Contractor is to investigate on site and locate any existing available hole which may be re-used for new systems.
 - .2 The Contractor is to prepare a layout sketch showing all existing openings and holes and required new openings and holes, with size and locations to the closest grid line in both directions, and submit for review and approval by the Departmental Representative.
 - .3 Refer to the structural documents for requirements for reinforcing at each location.
 - .4 The Contractor is to proceed with reinforcing tracing as per requirements and scanning for electrical conduit. Scanning to be completed using ground penetrating Radar (GPR) technology.
 - .5 The Contractor shall identify at each location prior to coring and cutting the location, direction and layer of each reinforcing bar and conduit.
 - .6 Any core or opening where reinforcing steel was cut during the cutting and coring process must be retained on site, and the Contractor must inform the Departmental Representative with the following information: size of the reinforcing bar, reinforcing layer location (top steel or bottom slab steel) and direction of the bar (east – west or north – south).
- .3 Patch and make good surfaces cut, damaged or disturbed, to the Departmental Representative's approval. Match existing material, colour, finish, and texture or as indicated otherwise.
- .4 Provide dust-tight screens or partitions to localize dust generating activities and for protection of finished areas of work, workers, and the public.
- .5 Refer to special precautions required for work within or penetrating the clean room areas.

1.19 MECHANICAL COST BREAKDOWN

- .1 Upon award of contract, provide mechanical cost breakdown in accordance with Section 01 00 10 – General Instructions.

1.20 TESTING ADJUSTING AND BALANCING (TAB) FOR HVAC

- .1 Contractor shall allow for complete testing, adjusting and balancing of system within tender quotation. Allow for two (2) days of on site assistance during testing, balancing
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and commissioning for coordination efforts with mechanical contractor, controls contractor and Department Representative.

- .2 Purpose:
 - .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
 - .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal operating conditions and emergency conditions.
 - .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges and modes.

1.21 DEMONSTRATION AND TRAINING

- .1 The Contractor shall provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being general “canned” training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach.
- .2 Provide one (1) - eight (8) hour day of classroom instruction. One (1) comprehensive training manual (English) shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor.
- .3 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the equipment location.
- .4 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .5 Review contents of manual in detail to explain aspects of operation and maintenance.
- .6 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.
- .7 Training Program:
 - .1 Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. This phase shall be augmented with on-the-job training during the fifteen (15) day acceptance period. Training shall include the following:
 - .1 General EMCS architecture (overview).
 - .2 On-site review of all system components with brief descriptions of functions and details.
 - .3 System Communications (overview).
 - .4 Operator interface functions for control of HVAC systems (detailed).
 - .5 Control descriptive logic (detailed for each system).
 - .6 Report generation (overview).

- .7 Elementary preventative maintenance (detailed).
 - .1 General equipment layout.
 - .2 Troubleshooting of all EMCS components.
 - .3 Preventative maintenance of all EMCS components.
 - .4 Sensors and controls maintenance and calibration.

1.22 DFL MECHANICAL STANDARDS

- .1 All materials and workmanship shall - as a minimum - be in accordance with the latest edition of the following:
 - .1 National Building Code - NBC,
 - .2 Ontario Building Code (OBC),
 - .3 AN / CGA - b149.1 & .2, ASHRAE 90.1
 - .4 Ontario plumbing & fire codes,
 - .5 NFPA standards, particularly NFPA 13, 14 & 96,
 - .6 All other applicable provincial, municipal and safety codes and regulations.
 - .2 Confirm all piping / ductwork dimensions and elevations on site prior to installation or ordering equipment. Contractor shall allow
1. Contractor to arrange for all necessary hot work permits, allow for 24 hours' notice at least for CSA to issue.
 2. Be responsible for removal and reinstating ceilings as necessary. Protect T-bar grid & tiles during work.
 3. Contractor shall be responsible for relocating any services obstructing the path of new piping / ductwork / equipment and shall do so after engineer's approval and at no additional cost.
 4. Smoke eaters & powered exhaust fans vented to outside of building must be used during all brazing / welding / soldering / cutting / grinding activities to minimize contamination & odor to adjacent areas particularly in clean rooms.
 5. All building HVAC return / exhaust grills within construction area must be blocked at all times during construction. Provide dust seals or temporary filters on all supply diffusers. Do not operate HVAC until final clean-up.
 6. Contractor to provide complete system of pipe supports and to anchor all piping in accordance with MSS SP-58 and MSS SP-69 and to match existing building supports. All supports & hangers to be e. MYATT, ITT Grinnell, copper b-line or approved equal. Provide full support plan to engineer for approval before commencing work.
 7. Contractor to support piping from structural members with clevis hangers at adequate spacing to insure no sag or failure of joints. Adequately brace piping and allow for expansion or contraction.
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- Provide expansion loops or joints sized to compensate for changes in pipe length caused by a temperature differential of 150°F (65°C)
8. Use of perforated band, wire chain or solid ring type hangers is not permitted.
 9. Use of c-clamps on beams is not permitted, use beam clamp to support all threaded rods.
 10. Several systems or part of systems will be subject to a shut-down period. Be responsible for having all necessary tools, manpower and equipment required to maximize the production during a shut-down. All shut downs shall be coordinated with project manager and the engineer with a 48 hours' notice.
 11. Verify the exact location of existing services and mains to be tying-in, removed or capped prior to commencing work.
 12. Provide vibration hanger kit & duct flexible connections to all ceiling exhaust fans. Wire bridge all duct connectors for electrical continuity, use #8 AWG.
 13. Use flat bottom duct transition pieces for effective drainage.
 14. All duct work and sheet metal shall be in accordance with S.M.A.C.N.A. - low velocity system.
 15. Seal all longitudinal and circumference duct joints with high velocity duct sealer, "Duro Dyne" or approved equal.
 16. As a minimum, provide 1" thick, heavy density, rigid fiberglass insulation with vapor barrier and jacketing on all plumbing piping. Insulate the last 10 feet from outside of all exhaust & fresh air intake ductwork with 1 1/2" fiberglass wrap. All insulation joints to be staggered. All joints to be taped with foil tape, electric tape is not permitted. Provide removable insulation joints at all valves & unions with Velcro strips.
 17. All exposed jacketing to be GCI .016" Alumaclad, pebbled (stucco) finish.
 18. Provide 12" insulation protection galvanized shield / saddle plates with lock tabs at each pipe hanger location.
 19. All piping to be pressure tested for a minimum of 24 hours and in accordance with the code requirements, do not conceal or insulate any piping until tested, inspected & approved by engineer.
 20. Provide new volume control and splitter dampers on all new and modified ductwork. Fire dampers must be provided on all ducts or air transfer openings penetrating a building fire separation.
 21. Flexible ducts shall be limited to a maximum length of 6 feet and minimum diameter of 6".
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22. All HVAC controls and wiring shall be sized, selected by a specialized controls sub-trade in full accordance with equipment manufacturer recommendations.
 23. Isolate copper pipe from hanger or other piping where electrolytic action can occur.
 24. Vent and prime all p-trap fixtures in accordance with the Ontario latest edition plumbing code. Use automatic primers, "Ancon" or "Zurn" at all new & existing floor drains. All fixtures vent to be connected to the building common plumbing vents.
 25. Approved plumbing accessories & valves: Ancon, Zurn, Watts or Crane.
 26. All drainage and vent piping to be cast iron with MJ joints or DWV copper as rated by manufacturers for return air plenum use and approved by code.
 27. All plumbing piping shall be type "L" new copper with lead free soldered joints unless otherwise specified.
 28. All temperature & pressure gauges to be 4"~ 5" dial size, stainless steel & glycerin fill. Use thermos-wells on all temperature gauges.
 29. Use VMC Korfund Maxi-Flex neoprene mounting floor pads on all heavy equipment to isolate vibration & protect flooring. Grade / color to match load.
 30. Use Parker QIX filter / regulator w/ gauge at all compressed air terminals, model B20-G.
 31. Use Armstrong CBV for all circuit balancing valves.
 32. All fire protection work to be carried out by CFAA technicians. Distribute all pendant sprinkler heads in accordance with NFPA-13 ordinary hazards classification. All new pendant heads to be recessed series RFII – Royal Flush II by TYCO – model# TY3551 or approved equal. Contractor to engage "Simplex Grinnell" in all sprinklers work and "Chubb Edwards" on all fire panel modifications & commissioning.
 33. Label all piping, equipment & ductwork with reference to their service and location. Use W.H.Brady labels style, B-946 vinyl film, 2" wide. Match building identification / labeling system as follow:
 - White letters & arrows on green tape:
 - Domestic & separated cold water
 - Chilled water supply & return
 - Condensed & tower water supply & return
 - Drainage, sanitary, storm & vents
 - HVAC supply & return, exhaust air & fresh air intake ductwork
 - Black letters & arrows on yellow tape:
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- Domestic hot water
- Heating water supply & return
- Compressed air
- White letters & arrows on red tape:
 - Fire & sprinklers protection system
- White letters & arrows on blue tape:
 - Lab services (LN2, GN2 supply, purge & vents)

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 SEISMIC RESTRAINT

- .1 Provide services of a Seismic Engineer for the seismic design of isolation and seismic restraint and control.
- .2 Seismic restraints are to be provided for all operational and functional components of mechanical building systems in accordance with National Building Code, ASHRAE Standard – A Practical Guide to Seismic Restraint, SMACNA – Seismic Restraint Manual.
- .3 At the completion of the project the Seismic Engineer shall review the installations on site, and shall prepare a written report with a sealed letter certifying that the installations have been completed in accordance with their design and shop drawings.
- .4 Provide seismic restraint for the following systems:
 - .1 Pipe equal or larger than:
 - .1 65 mm diameter pipe in general areas
 - .2 30 mm diameter pipe in mechanical rooms
 - .3 25 mm diameter pipe containing natural gas.
 - .4 Any trapeze suspension, supporting items with a combined weight that exceeds the above items.
 - .2 Duct equal or larger than:
 - .1 0.55m² cross sectional area of duct.
 - .3 Base Mounted Equipment
 - .1 All base mounted equipment that meets any of the following conditions requires attachments and seismic restraint as specified by the Seismic Engineer:
 - .1 Connected to natural gas, or
 - .2 With an overturning movement, or

- .3 Greater than 181 kg of operational weight.
- .5 Elastomeric pads:
 - .1 Neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
 - .2 Rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .6 Elastomeric mounts:
 - .1 Colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.
- .7 Springs:
 - .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than
 - .2 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
 - .3 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
 - .4 Cadmium plate for outdoor installations.
 - .5 Colour code springs.
- .8 Hangers:
 - .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
 - .2 Stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

3.2 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
 - .2 Prime and touch up marred, finished paintwork to match original. Use primer or enamel to match original. Do not paint over the nameplates.
 - .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.
 - .4 Hangers, supports, and equipment fabricated from ferrous metals shall be given at least one coat of corrosion resistant primer paint before shipment to the job site.
 - .5 Touch-up damaged surfaces of all mechanical equipment and materials, to the satisfaction of the Departmental Representative. Use primer or enamel to match the original. Do not paint over the nameplates.
 - .6 Provide materials and labour to prime and paint all exposed ductwork in Bay 3, and Mechanical Room M6 after ductwork installation using brush or roller application.
 - .7 Departmental Representative will provide Colour Schedule after Contract award.
 - .8 Colour schedule will be based to match existing type and colour of paints (i.e. black in joist space, white in Mechanical Room M6).
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3.3 TESTING

- .1 General:
- .1 Test and verify all major subsystems of the complete EMCS including all field components.
 - .2 Testing shall be done in phases under the direction of the Departmental Representative.
 - .3 The Contractor shall provide all test equipment. Two-way radios will be provided by the Departmental Representative.
 - .4 All test equipment such as digital thermometers, humidistat, volumeters, and milliamp and volt meters shall be certified as accurate by an independent testing laboratory no later than one (1) month prior to the tests.
 - .5 Notify the Departmental Representative in writing at least seven (7) days before testing is to take place.
 - .6 Provide all necessary personnel and co-ordination with other trades.
 - .7 Perform tests in presence of the Departmental Representative.
 - .8 Demonstrate the proper operation of each component.
 - .9 Correct any deficiencies and re-test in the presence of the Departmental Representative, until designated part of the system performs satisfactorily.
 - .10 Acceptance of tests by the Departmental Representative shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

3.4 COMPLETION TESTS

- .1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.
- .2 Test and calibrate all field and OWS hardware including stand alone capabilities of each Controller.
- .3 Verify each Analog to Digital converter.
- .4 Check all operating software.
- .5 Check all application software. Provide samples of all logs and commands.
- .6 Verify each CDL including energy optimization programs.
- .7 Check all alarms for proper operation by actual trip of field instrumentation and equipment. Obtain Departmental Representative's authorization before proceeding.
- .8 Debug all software.
- .9 Blow out flow measuring and static pressure stations with high pressure air.

3.5 FINAL OPERATIONAL ACCEPTANCE TEST

- .1 A final operational test of not less than fifteen (15) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total EMCS system and all monitored and controlled equipment included in this Tender.
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- .2 Demonstrate that it is functioning properly in accordance with all requirements of this specification.
- .3 The correct operation of all monitored controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software.
- .4 If the equipment operates at an average effectiveness level (AEL) of at least 99% during the performance test period of fifteen (15) consecutive calendar days, it will be deemed to have met Standard of Performance, and final acceptance of the system shall be made, provided the Contractor has satisfied all other requirements of this specification.
- .5 In the event the required AEL is not reached during the initial fifteen (15) calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for fifteen (15) consecutive calendar days. The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period.
- .6 Downtime shall result whenever the EMCS is unable to fulfill all required functions detailed within this specification due to any malfunction of either hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed.
- .7 System downtime for each incident shall be measured by those intervals during the performance period between the time that the Contractor or duly authorized representative is notified of equipment failure and the time that the system is returned to proper operating condition. Notification of down time shall be by means of OWS located in the Contractor's office and a modem to the system. Downtime of the system resulting from the causes as follows will not be considered as system failures:
 - .1 Downtime resulting from an outage of the main power supply in excess of the capability of any back-up power source(s), provided that the automatic initiation of all back-up sources was accomplished and provided that the automatic shutdown and restart of components fulfills the requirements of this specification.
 - .2 Failure of a communications link, provided that the Controllers automatically and correctly operates in the stand-alone mode and provided that the failure was not due to a failure of Contractor-furnished equipment.
 - .3 A functional failure resulting from an individual sensor or controller provided that the system has recorded the fault, the mechanical equipment is defaulted to the fail-safe mode, and that the AEL of the total of sensors and controllers is at least 99% during the thirty-day test period.

3.6 FINAL COMMISSIONING

- .1 When the Contractor is satisfied as to proper system operation they shall advise the Departmental Representative to establish a date for detailed Final Acceptance. This will involve a point-by-point check of all hardware and software items including graphics and displayed data, as well as perform tasks as directed.
 - .2 This phase of the work shall be carried out under the complete direction of the Departmental Representative or his authorised representative.
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- .3 Provide at least one (1) technical personnel capable of re-calibrating all field hardware and modifying software.
- .4 Provide a detailed daily schedule showing items to be tested and personnel available. All equipment must be verified locally for operation and alarms.
- .5 The key document for recording the commissioning shall be a listing of the system data base. The document shall be prepared by the EMCS Contractor for the Departmental Representative's approval. This listing shall include the key name or tag, English description, point type and address, engineering units, low and high limits, and a space for remarks and Departmental Representative's acceptance signature.
- .6 The Departmental Representative's acceptance signature shall also be required for all executive and application programs as specified.
- .7 Once final commissioning is complete provide a complete new set of filters for all equipment.

3.7 DEMONSTRATION

- .1 The Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, materials, and instruments required for testing.
- .2 Trial usage to apply to the following equipment and systems:
 - .1 AHU-7 & 8.
 - .2 Humidifier and control valves.
 - .3 Duct Systems.
 - .4 Controls.
 - .5 Fire Alarm Connections Interlocks.
 - .6 EMCS and sequences of operation.
- .3 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operations and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials

- .1 All Bidders will be required to list the mechanical sub-trades for the part of work as listed below at Tender close.

Once submitted, no changes will be permitted without the written consent of the Departmental Representative.

NAME

Prime Bidder

MECHANICAL SUB-TRADE:

- .1 Plumbing and Utilities:
(if not prime)

- .2 Ventilation and
Air Conditioning:
(if not prime)

- .3 Pipe and Duct
Insulation:

- .5 Controls:

Johnson Controls Canada LP

ELECTRICAL SUB-TRADE:

- .1 Electrical:

- .2 Fire Alarm:

Chubb Edwards

Tenderer's Signature or if
Tender is submitted by an
incorporated company its
seal attested by the hands of
its proper officers

Signature/Seal

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C111/A21.11-07, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .2 ANSI B 36.19M-04 Stainless Steel Pipe
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .2 ASME B 16.9-07, Factory-Made Wrought Butt Welding Fittings.
- .3 ASTM International
 - .1 ASTM A 47/A 47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM B 61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM A 53/A 53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
 - .4 ASTM A 312/A 312M-12, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - .5 ASTM A 536-84(2009), Standard Specification for Ductile Iron Castings.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA B139-04, Installation Code for Oil Burning Equipment.
 - .2 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .3 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- .6 National Fire Code of Canada (NFCC 2010)
- .7 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)

Part 2 Products

2.1 PIPE

- .1 Steam:
 - .1 Seamless stainless steel pipe: to A 312/A 312M, Schedule 40S.
 - .2 Chilled/hot water:
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- .1 Steel pipe: to ASTM A 53/A 53M, Grade B, Schedule 40.
- .3 Domestic hot, cold and recirculation systems, within building.
 - .1 Above ground: copper tube, hard drawn, type L: to ASTM B 88M.
- .4 Drainage, condensation:
 - .1 Cast Iron DWV
 - .2 Copper DWV (pipes 32mm diameter and larger)
 - .3 Copper type L (pipes smaller than 32mm diameter)

2.2 PIPE JOINTS

- .1 Steel Piping:
 - .1 NPS 2 and under: welding fittings and flanges to CSA W48.
 - .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
 - .3 Screwed fittings shall be acceptable on NPS 2 and under where indicated for ease of servicing.
- .2 Copper Piping:
 - .1 Brazed 95:5 silver solder to ANSI/AWS A5.8
- .3 Flanges: weld neck
- .4 Orifice flanges: slip-on raised face, 2100 kPa.
- .5 Flange gaskets: to ANSI/AWWA C111/ A21.11.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .8 Roll grooved fittings shall not be acceptable.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.9, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Stainless steel: to ASME B16.9.
 - .2 Brass or bronze
 - .3 Cast Iron
- .3 Butt-welding fittings: ASME B16.9.
- .4 Unions: malleable iron, to ASTM A 47/A 47M and ASME B16.3.
- .5 Wrought copper and copper alloy solder joint pressure fittings to ANSI/ASME B 16.4.

2.4 THERMAL INSULATION FOR PIPING

- .1 Fire and smoke rating
 - .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
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- .2 Maximum smoke developed rating: 50.
 - .2 Insulation
 - .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
 - .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
 - .3 Minimum thickness: 25mm, unless specified otherwise.
 - .4 Thickness: As per ASHRAE 90.1 latest version.
 - .2 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
 - .3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
 - .4 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
 - .5 Insulation securement
 - .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
 - .2 Contact adhesive: quick setting.
 - .3 Canvas adhesive: washable.
 - .4 Tie wire: 1.5 mm diameter stainless steel.
 - .5 Bands: stainless steel, 19mm wide, 0.5 mm thick.
 - .6 Cement
 - .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting on mineral wool, to ASTM C 449/C 449M.
 - .7 Vapour retarder lap adhesive
 - .1 Water based, fire retardant type, compatible with insulation.
 - .8 Indoor vapour retarder finish
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .9 Jackets
 - .1 Aluminum:
 - .1 To ASTM B 209.
 - .2 Thickness: 0.50 mm sheet.
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- .3 Finish: stucco embossed.
- .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.5 THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB 14.4 & ASME B40.200.
- .2 Thermometer wells shall be copper for copper piping and brass for steel piping.

2.6 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.

2.7 VALVES

- .1 NPS 2 and smaller: ends for soldering.
- .2 NPS 2 1/2 and larger: flanged.
- .3 Butterfly valves: for isolation on systems NPS 2 1/2 and larger
- .4 Globe valves: used for throttling or flow control.
- .5 Circuit Balancing Valves: calibrated balancing valves for flow balancing.
- .6 Ball Valves: for isolation on NPS 2 and under.

2.8 AUTOMATIC AIR VENTS

- .1 Standard float type: brass body and NPS 1/8 connection and rated at 310 kPa working pressure.

2.9 PIPE STRAINER

- .1 NPS 2 and smaller: bronze body to ASTM B 62 soldered ends, y pattern.
- .2 NPS 2 1/2 and larger: cast iron body to ASTM A 278/A 278 M, class 30, flanged connections.
- .3 Blowdown connections 25mm.
- .4 Stainless steel screen with 1.19mm perforations.

Part 3 Execution

3.1 THERMOMETERS

- .1 Install so they can be easily read from floor.
 - .2 Install between equipment and first isolation valve.
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- .3 Install in wells on piping with heat conductive paste inside well.
- .4 Install on inlet and outlet of all coils.
- .5 Use extensions where installed through thermal insulation.

3.2 PRESSURE GAUGES

- .1 Install as follows:
 - .1 Inlet and outlet of coil
 - .2 Upstream and downstream of control valves
 - .3 As indicated
- .2 Install ball valves for isolation of pressure gauges.
- .3 Use extension where installed through thermal insulation.

3.3 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly/disassembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.4 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicate (whichever is greater) without interrupting operation of other system, equipment, and components.

3.5 DRAINS

- .1 Install piping with in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.6 AIR VENTS

- .1 Install air vents at high points in piping systems.
 - .2 Install isolating ball valve at each automatic air valve.
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3.7 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.8 PIPE WORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
 - .2 Protect openings against entry of foreign material.
 - .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
 - .4 Assemble piping using fittings manufactured to ANSI standards.
 - .5 Saddle type branch fittings will not be permitted. A proper fitting with new connection shall be welded into the existing supply pipe.
 - .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
 - .7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
 - .8 Install, except where indicated, to permit separate thermal insulation of each pipe.
 - .9 Group piping wherever possible.
 - .10 Ream pipes, remove scale and other foreign material before assembly.
 - .11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
 - .12 Provide for thermal expansion as required.
 - .13 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Provide stem handle extensions as required to allow for clearance to insulation.
 - .9 Layout valves to ensure full stroke of valve handle. No modifications of valves handles will be permitted to allow for full valve actuation.
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3.9 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for fire stopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.10 PREPARATION FOR FIRE STOPPING

- .1 Install fire stopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Before start-up, clean interior of new piping systems.
 - .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.
 - .3 Contractor shall allow for additional isolation valves, connection points, bypass connection and circulator to ensure complete flushing and cleaning of new piping systems.
 - .4 Prior to commencement of work provide Department Representative with proposed flushing and cleaning procedures including list of chemicals used and concentrations. Procedure shall be reviewed and approved by Department Representative.
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3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate work only after approval and certification of tests by Departmental Representative.

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative. Be responsible for damage to existing plant by this work.

3.14 PIPE THERMAL INSULATION

- .1 Insulate all heating and steam piping to TIAC code A1 c/w aluminum jacketing. Thickness shall be as per ASHRAE 90.1 with a minimum thickness of 25mm.
- .2 Insulate all chilled water piping to TIAC code A3 c/w aluminum jacketing. Thickness shall be as per ASHRAE 90.1 with a minimum thickness of 25mm.
- .3 Provide removable pre-fabricated insulation enclosures for all valves, flanges and unions. Pre-fabricated enclosures to match TIAC code and jacketing of system.

3.15 AUTOMATIC AIR VENTS

- .1 Provide at high points of the systems and coil headers.
- .2 Provide ball isolation valve on all air vents.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2007, Power Piping.
 - .2 ANSI/ASME B31.3-2006, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-2007:
 - .1 BPVC 2007 Section I: Power Boilers.
 - .2 BPVC 2007 Section V: Nondestructive Examination.
 - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .2 AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.
 - .3 AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
 - .4 AWS W1-2000, Welding Inspection Handbook.

1.3 Qualifications

- .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications to Departmental Representative.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.
 - .2 Certifications:
 - .3 Registration of welding procedures in accordance with CSA B51.
 - .4 Copy of welding procedures available for inspection.
 - .5 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.4 DELIVERY, STORAGE AND HANDLING

Deliver, store and handle in accordance with Section 01 61 00-Common Product requirements.

Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

Part 2 Products

2.1 Electrodes

- .1 Electrodes:
 - .1 In accordance with: CSA W48 Series.

Part 3 Execution

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS-GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 INSPECTION AND TEST-SPECIALIST

- .1 General:
-

- .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 30% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests.
 - .4 Hydrostatically test welds to ANSI/ASME B31.1.
 - .5 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .2 Failure of visual examinations:
- .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative up to 10% of welds, selected at random by Departmental Representative by particle tests.
-

3.6 REPAIR OF FAILED WELDS

- .1 Re-inspect and re-test reworked or repaired welds at contractor's expense.

3.7 CLEANING

- .1 Work site to be cleaned and maintained in a clean state everyday.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18[2001, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - .4 ASME B1.20.1-1983(R2006), Pipe Threads General Purpose (Inch).
 - .5 ASME B16.1-05, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25,125 and 250.
 - .2 ASTM International
 - .1 ASTM A 276-08, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B 283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B 505/B 505M-08a, Standard specification for copper-base alloy continuous castings.
 - .5 ASTM A 49-01(2006), Standard Specification for Heat-Treated Carbon Steel Joint Bars.
 - .6 ASTM A 126-04, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .7 ASTM A 536-84(2004) e1, Standard Specification for Ductile Iron Castings.
 - .8 ASTM B 61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .9 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .10 ASTM B 85/B 85M-08, Standard Specification for Aluminum-Alloy Die Castings.
 - .11 ASTM B 209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .12 ASTM A 126-04), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
-

- .4 MSS SP-61-03, Pressure Testing of Steel Valves.
- .5 MSS SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
- .6 MSS SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
- .7 MSS SP-82-199], Valve Pressure Testing Methods.
- .8 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

Part 2 Products

2.1 VALVES

- .1 Except for specialty valves, to be single manufacturer.
- .2 Products to have CRN registration numbers.
- .3 Cast steel or iron:
 - .1 Body, bonnet: cast iron to ASTM B 209 Class B
 - .2 Connections: flanged ends plain face to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for hand wheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Hand wheel: die-cast aluminum alloy to ASTM B 85/B 85M or malleable iron to ASTM A 49. Nut of bronze to ASTM B 62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.

2.2 END CONNECTIONS:

- .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends to ANSI/ASME B16.18.

2.3 GLOBE VALVES:

- .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
-

-
- .6 Hand wheel: non-ferrous.
 - .7 Hand wheel Nut: bronze to ASTM B 62.
 - .8 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, re-grindable bronze seat, loosely secured to bronze stem to ASTM B 505.
 - .3 Operator: hand wheel

2.4 BALL VALVES:

- .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B 62
 - .2 Pressure rating: Class125, 860 kPa steam.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulder & solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.

2.5 BUTTERFLY VALVES:

- .1 NPS 2 1/2 through NPS 6, 2068 kPa with flanged ends:
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International
 - .1 ASTM A 125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A 307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A 563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP 58-2002, Pipe Hangers and Supports Materials, Design and Manufacture.
 - .2 MSS SP 69-2003, Pipe Hangers and Supports Selection and Application.
 - .3 MSS SP 89-2003, Pipe Hangers and Support Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
 - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP 58.
 - .6 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers to withstand seismic events.
-

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58. ANSI B31.1
- .2 Use components for intended design purpose only.
- .3 Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized.
 - .2 Use hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated.
 - .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .2 Rod: 9 mm UL listed
 - .3 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed and MSS-SP 69.
 - .3 Upper attachment structural: suspension from upper flange of I-Beam
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed and MSS SP 69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed..
 - .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed and MSS SP 69.
 - .5 Shop and field-fabricated assemblies:
 - .1 Sway braces for seismic restraint systems: retain services of Seismic Engineer, submit stamped and sealed shop drawings submissions.
 - .2 Support of Bay 3 Return Air Duct Header: Retain services of Structural and Seismic Engineer for design and fabrication of support structure serving Return Air Duct Header.
 - .6 Hanger rods: threaded rod material to MSS SP 58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
-

- .7 Pipe attachments: material to MSS SP 58:
 - .1 Attachments for steel piping: carbon steel.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP 69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.
- .10 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A 563
 - .1 Finishes for steel pipework: black.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.

2.4 INSULATION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 69.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with Manufacturer's instructions and recommendations.
- .2 Vibration Control Device:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

Part 1 General

1.1 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A-2012, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .4 American Society for Testing and Materials (ASTM).
- .5 Sheet Metal Air Conditioning Contractors' National Association (SMACNA).
- .6 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .7 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .8 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN4-S112-10, Fire Test of Fire Damper Assemblies.
 - .3 CAN4-S112.2-07, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .4 ULC-S505-1974, Fusible Links for Fire Protection Service.

Part 2 Products

2.1 DUCTWORK

- .1 Material:
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-
- .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A 653/A 653M.
 - .2 Minimum thickness:

| <u>Area</u> | <u>Gage</u> |
|--------------------|-------------|
| Mechanical Room M6 | 18 |
| <u>Bay 3</u> | <u>14</u> |
 - .2 Construction - round and oval.
 - .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
 - .2 Transverse joints up to 900mm: slip type with tape and sealants.
 - .3 Transverse joints over 900mm: Vanstone.
 - .4 Fittings:
 - .1 Elbows: smooth radius. Centreline radius: 1.5 x diameter.
 - .2 Branches: conical transition with conical branch at 45 degrees and 45 degrees' elbow.
 - .3 Construction - rectangular:
 - .1 Ducts: to SMACNA.
 - .2 Transverse joints: flanged and gasketed joints, SMACNA seal Class A.
 - .3 Fittings:
 - .1 Elbows: smooth radius; centreline radius 1.5 x width of duct with turning vanes.
 - .2 Branches: with conical branch at 45 degrees and 45 degrees elbow.
 - .4 Fire stopping:
 - .1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.
 - .2 Fire stopping material must not distort duct.

2.2 SEAL CLASSIFICATION

- .1 Seal classification: SMACNA Seal Class A, longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

2.3 SEALANT

- .1 Oil resistant, polymer type flame resistant high velocity duct sealing compound.

2.4 TAPE

- .1 Polyvinyl treated, open weave fibre glass, 50 mm wide.

2.5 HANGERS AND SUPPORTS

- .1 Band hangers: install in accordance with SMACNA.
 - .2 Angle hangers: complete with locking nuts and washers.
 - .3 Hangers: steel rods to the following table:
-

| <u>Duct Size</u> | <u>Angle Size</u> | <u>Rod Size</u> |
|------------------|-------------------|-----------------|
| (mm) | (mm) | (mm) |
| Up to 750 | 25 x 25 x 3 | 6 |
| 751 to 1050 | 40 x 40 x 3 | 6 |
| 1051 to 1500 | 40 x 40 x 3 | 10 |
| 1501 to 2100 | 50 x 50 x 3 | 10 |

- .4 Upper hanger attachments:
 - .1 For steel joist: manufactured joist clamp or steel plate washer.
 - .2 For steel beams: manufactured beam clamps:

2.6 DUCT INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C 612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C 553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C 553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C 553.
- .5 Jackets
 - .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
 - .2 Lagging adhesive: compatible with insulation.
 - .3 Aluminum:
 - .1 To ASTM B 209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Stucco embossed.
 - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.
 - .5 Metal jacket banding and mechanical seals: stainless

2.7 AIR DUCT ACCESSORIES

- .1 Insulated flexible duct connections
 - .1 Frame: galvanized sheet metal frame 100 mm thick with fabric clenched by means of double locked seams.
 - .2 Material:
-

-
- .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of
 - .2 1.3 kg/m².
 - .3 25mm thermal insulation.
 - .3 Grounding:
 - .1 #6 AWG stranded copper braided wire to bridge ducts on either side of flexible connection.
 - .2 Access doors in ducts
 - .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
 - .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
 - .3 Gaskets: neoprene.
 - .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
 - .5 Size:
 - .1 450 x 450 mm for person size entry.
 - .2 450 x 450 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 As indicated.
 - .6 Locations:
 - .1 At fire dampers.
 - .2 At control dampers.
 - .3 At Devices requiring maintenance.
 - .4 At locations Required by code.
 - .5 At Reheat coils.
 - .6 Elsewhere as indicated.
 - .3 Turning vanes
 - .1 Factory or shop fabricated, to recommendations of SMACNA.
 - .4 Instrument test ports
 - .1 1.6 mm thick steel zinc plated after manufacture.
 - .2 Cam lock handles with neoprene expansion plug and handle chain.
 - .3 28 mm minimum inside diameter. Length to suit insulation thickness.
-

.4 Neoprene mounting gasket.

2.8 DAMPERS – BALANCING

.1 Splitter dampers

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

.2 Single blade dampers

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

.3 Multi-bladed dampers

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm.
- .4 Bearings: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage: 0.07 % at 1000 Pa.

2.9 DAMPERS-OPERATING

- .1 Operating dampers shall be multi-leaf type.
 - .2 Dampers for the purpose of on/off operation shall be parallel blade arrangement actuation.
 - .3 Dampers for the purpose of air flow control (throttling) shall be of opposed blade actuation arrangement.
 - .4 Dampers shall be of extruded aluminum type blade, interlocking blades, vinyl seals, spring stainless steel side seals and structurally formed extruded aluminum frame.
 - .5 Pressure fit self-lubricated bronze bearings
 - .6 Linkage shall be plated steel tie rods, brass pivots with control rod and brackets.
-

- .7 Performance shall be leakage less than 2% of rated air flow at 250kPa differential pressure across damper.
- .8 Provide insulated aluminum dampers where exposed to the outside conditions such as outdoor air damper and exhaust air dampers.
 - .1 Frame shall be insulated with extruded polystyrene foam with RSI 0.88.
 - .2 Frame shall be thermally broken.
 - .3 Blades shall be aluminum with internal hollows insulated with polyurethane foam, RSI 0.88.
- .9 Damper actuator shall be Belimo, 24V c/w spring return and end switch.

2.10 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B or C, listed and bear label of ULC, meet requirements of Fire Commissioner of Canada (FCC) and ANSI/NFPA 90A. Fire damper assemblies fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; interlocking type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair
- .7 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.
- .8 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with ASHRAE and SMACNA.
 - .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate band hangers 100 mm beyond insulated duct.
 - .2 Ensure diffuser is fully seated.
 - .3 Support risers in accordance with SMACNA.
-

- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Ensure installation of firestopping does not distort duct.

3.2 HANGERS AND STIFFENERS

- .1 Band hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Minimum hanger spacing as follows:

| Duct Size (mm) | Spacing (mm) |
|-------------------|-----------------|
| up to 1500 | 1200 |
| 1501 and over | 2000 |

- .4 Minimum stiffener spacing as follows:

| Duct Size (mm) | Spacing (mm) |
|-------------------|-----------------|
| up to 750 | 1200 |
| 751 to 1,650 | 1500 |

3.3 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA and manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.4 DUCT INSULATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 200 mm on centre in horizontal and vertical directions, minimum 2 rows each side.
- .7 Ductwork insulation schedule

- .1 Insulation types, thicknesses and jacketing: Conform to following table:

| (1) Material Type | (2) TIAC Code Retarder | (3) Vapour | (4) Thickness (mm) | (5) Jacket |
|--------------------------------------|---------------------------|---------------|-----------------------|---------------|
| Exposed Rectangular Supply Air Ducts | None | None | None | None |

| | | | | |
|--|------|---------|------|--------|
| Exposed Return Ducts in Space Being Served | None | None | None | None |
| Exposed Outdoor Air Ducts | C-1 | Special | 50 | Canvas |
| Exposed Relief Air Ducts | C-1 | Special | 50 | Canvas |
| Acoustically-Lined Ducts | None | None | None | |

3.5 AIR DUCT ACCESSORIES

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units.
 - .2 Length of connection: 100mm.
 - .3 Grounding:
 - .1 #6 AWG stranded copper braided wire to bridge ducts on either side of flexible connection.
 - .4 Minimum distance between metal parts when system in operation: 75 mm.
 - .5 Install in accordance with recommendations of SMACNA.
 - .6 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to air handling unit in Mechanical Room M6.
 - .2 Main and sub-main ducts.
 - .2 For temperature readings:
 - .1 At outside air intakes.

3.6 DAMPERS – BALANCING

- .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
-

- .2 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .3 Runouts to registers and diffusers: install splitter dampers located at each runout serving single register or diffuser.
- .4 Main duct trunks: install balancing dampers at all main trunks of ductwork.
- .5 Dampers: vibration free.
- .6 Corrections and adjustments made by Division 23 to achieve indicated volume of airflow.
- .7 Ensure damper operators are observable and accessible.

3.7 DAMPERS – FIRE

- .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation. Co-ordinate with installer of fire stopping.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

3.8 CONNECTION TO DIFFUSERS AND REGISTERS

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head, cadmium plated screws in countersunk holes where fastenings are visible to flanged ductwork with screws.
- .3 Provide concealed safety chain on each grille, register and diffuser
- .4 Coordinate spacing for screws with diffuser and register shop drawings.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C 423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM E 90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .3 ASTM E 477-99, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .4 Material Safety Data Sheets (MSDS).
- .5 National Building Code (NBC)-2015
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 – General Instructions Silencers supplied and installed by this contractor.

Part 2 Products

2.1 ABSORPTION AND INSULATING MEDIA

- .1 Acoustic quality, glass fibre, bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.
- .2 Due to cleanroom all acoustic media shall be encapsulated with two layers of fiber free film.

2.2 SILENCERS

- .1 Factory manufactured of prime coated or galvanized steel, compatible with ductwork specified elsewhere and to ASHRAE and SMACNA standards.
 - .2 Outer casing and galvanized steel inner casing with clean cut circular perforations to enclose acoustic media. Inner casing to have half-splitters running full length of silencer where any cross sectional dimension exceeds 450 mm. Protect media from erosion with two layers of non-fibrous membrane between media and perforated metal.
 - .3 Insulation and media shall contain no formaldehyde. Provide documentation proving such.
-

- .4 Performance shall be as per drawings, but silencer shall provide final selection of silencer by acoustic calculation using AHU reviewed shop drawing sound power, ductwork and diffuser layout to attain a sound level of NC 35 in the occupied space.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's and SMACNA recommendations.
.2 Reinforce and brace as indicated.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)
 - .1 ANSI/NFPA 96-04, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
 - .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E 90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .4 Material Safety Data Sheets (MSDS).
 - .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00-Common Product requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

Part 2 Products

2.1 FIXED PENTHOUSE LOUVRES-ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth.
 - .2 Material: extruded aluminum alloy 6063-T5.
 - .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
 - .4 Frame, head, sill and jamb: 100 mm deep one-piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit. Contractor shall coordinate frame thickness to suit each louvre location prior to submitting shop drawings.
 - .5 Mullions: at 1500 mm maximum centres.
 - .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.
 - .7 Screen: 12 mm mesh, 2 mm diameter wire aluminum bird screen on inside face of louvres in formed U-frame.
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- .8 Where indicated provide penthouse louvres. Penthouse louvres shall comply with this specification section. Corners shall be mitered. Provide 450mm high insulated seismically rated roof curb under penthouse louver. Seal all joints. Roof shall be sloped for drainage.
- .9 Finish: factory applied enamel. Colour shall be custom to Departmental Representative approval.

Part 3 Execution

3.1 INSTALLATION

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

Part 1 General

1.1 INTENT

- .1 The intent of this Section is to provide guidelines to define the minimum acceptable standards for the field instrumentation and control devices installed in the Air Handling Unit (AHU). The programming and execution of the EMCS operating sequences will be performed by the Controls Contractor.
- .2 All instruments and devices shall be subject to the Departmental Representative's approval.
- .3 Provide all safety interlocks in AHU required to prevent AHU from operating in an unsafe condition (i.e. if bypass, return and exhaust air dampers are closed return air fans shall not operate).

1.2 QUALITY CONTROL

- .1 ISO 9000
- .2 CSA

1.3 SHOP DRAWINGS

- .1 In accordance with Section 01 33 00 - Submittal Procedures and as specified herein.
- .2 One-line diagram from sensor and control points to Field Interface device and/or Terminal Control Unit including all components and cables.
- .3 All instruments, control devices, attachments and accessories, complete with specifications and calibration details.

1.4 GENERAL REQUIREMENTS

- .1 Provide all remote sensing points and instrumentation as required for the complete Energy Monitoring and Control System. All sensors shall have the accuracy as stated hereinafter. Hysteresis, relaxation time, span, maximum/minimum limits, etc., shall also be accounted for in all application of sensors and controls.
- .2 All instruments of a particular category shall be of the same type and manufacturer and shall be complete with all attachments and accessories suitable for the intended service.
- .3 All external trim material shall be completely corrosion-resistant with all internal parts assembled in watertight, shockproof, vibration-proof, heat-resistant assembly.
- .4 Use standard conduit box termination with slot screwdriver compression connector block unless otherwise specifically stated.
- .5 Operating conditions -0° to 32°C with 10 – 90% RH (non-condensing) unless otherwise specifically stated.
- .6 Provide manufacturer's installation instructions for all supplied equipment. All equipment shall be installed in accordance with Manufacturer's recommended methods and procedures.
- .7 All controllers shall be BACNET MSTP or IP protocol approved and compatible.

- .8 The following Control Description Logic (CDL) is a general description control logic and should not be construed as a detailed programming sequence or considered as a restriction to the vendor from including any additional features deemed as good engineering practice or normally included in the vendors' CDL. The controls vendor is solely responsible to ensure that all controlled components are operating in harmony and at optimum efficiency to achieve the design intent described hereunder.
- .9 Any additional features, as mentioned above, shall be reported to the Departmental Representative.
- .10 I/O schedule does not show pseudo points needed for all CDL features. Be responsible for the provision of all additional points necessary for a fully operational control system.

1.5 BAS CONTRACTOR

- .1 Mechanical contractor shall retain the services of Johnson Control Canada LP for all controls scope of work related to this project.
- .2 All existing controls removals shall be by BAS contractor.
- .3 Design, supply and installation of all controls including integration to BAS system and graphics shall be by Johnson Controls Canada LP and coordinated with Departmental Representative.

Part 2 Products

2.1 TEMPERATURE TRANSDUCERS

- .1 Temperature Sensors:
 - .1 Resistance type (RTD).
 - .2 The following shall apply to resistance temperature sensors as applicable:
 - .1 RTDs shall be 1000 ohm at 0°C (± 0.12 ohms) platinum element with strain minimizing construction and three (3) integral anchored lead wires coefficient of resistivity of 0.00385 ohms/ohm/°C.
 - .2 Sensing element to be hermetically sealed.
 - .3 Stem and tip construction to be Copper or 304 Stainless Steel.
 - .4 Sensors to have a time constant response of less than three (3) seconds to a temperature change of 10°C.
 - .5 Immersion wells shall be of stainless-steel materials. Heat transfer compound to be compatible with sensor.
- .2 Temperature Sensors Types:
 - .1 Temperature sensors shall be of the following types:
 - .1 General Purpose Duct Type: Suitable for insertion into air ducts at any angle, insertion length of 457 mm as noted on schedule or drawings.
 - .2 Spring-Loaded Thermowell Type: Spring-loaded construction with compression fitting for 21 mm NPT well mounting. Lengths of 100 mm to 150 mm as noted.

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- .3 Averaging Duct Type: Continuous filament with immersion length of 6000 mm minimum. Probe to be bent, at field installation time, to a minimum radius of 100 mm at any point along the probe length without degradation in performance.
 - .4 Outside Air Type: Complete with non-corroding shield designed to minimize solar and wind effects, threaded fitting for mating to 21 mm conduit, probe length of 100-50 mm.
 - .5 Strap-On: For strapping on pipe surface or other applications where high temperature is encountered.
- .3 Temperature Transmitters:
- .1 As applicable, RTD temperature transmitter to be provided having the following minimum specifications:
 - .1 Input circuit to accept 3-lead, 1000 ohm at 0°C, platinum resistance detectors as specified above.
 - .2 Output signal of 4-20 mA into maximum of 1000-ohm load.
 - .3 Output short circuit and open circuit protection.
 - .4 Input short circuit and open circuit protection.
 - .5 Output variation of less than 0.2% of full-scale output for supply voltage variations of $\pm 10\%$.
 - .6 Combined non-linearity, repeatability and hysteresis effects not to exceed $\pm 0.5\%$ of full-scale output.
 - .7 Maximum current to a 1000-ohm RTD sensor not to exceed 5 mA.
 - .8 Integral, zero, and span adjustments.
 - .9 Temperature effect of $\pm 1.0\%$ full scale/50°C or less.
 - .10 Long-term output drift of equal to or less than 0.25% of full-scale output/6 months.
 - .11 Transmitters to be provided with ranges as follows:
 - .1 -50°C to +50°C, $\pm 0.5^\circ\text{C}$.
 - .2 0°C to +50°C, $\pm 0.25^\circ\text{C}$.
 - .3 0°C to 25°C, $\pm 0.1^\circ\text{C}$.
 - .4 0°C to 100°C, $\pm 0.5^\circ\text{C}$.
 - .5 10°C to 35°C, $\pm 0.25^\circ\text{C}$.
 - .12 The narrowest range is to be selected for each specific indication.
 - .13 Range of transmitters to be submitted with shop drawings.
- .4 Differential Temperature Transmitters:
- .1 Provide analog RTD temperature difference transmitter, using a matched pair of platinum resistance temperature detectors.
 - .2 RTDs to be matched to .025 ohm for 1000-ohm detectors.
 - .3 Temperature Effect: 55°C change ambient error 0.75% of space.
 - .4 Output signal of 4-20 MA.

- .5 Power supply 575 ohm at 24 VDC. Power supply effect less than 0.01°C per volt change.
- .6 Integral zero and span adjustment.
- .7 Output linear with temperature. Linearity error of $\pm 0.5\%$ of full-scale output.

2.2 RELATIVE HUMIDITY TRANSDUCERS

- .1 The RH series of Humidity/Temperature Transducer must be designed for use with automation, energy management, and process computer control/monitoring systems.
- .2 Description:
 - .1 The RH transducers shall be intended specifically for use in energy monitoring and control systems (EMCS). Its design combines microprocessor-based linearization and temperature correction with a high-class resistance sensor. A field-interchangeable sensor combined with integral zero and span adjustments shall provide long-term reliability and accuracy for the most critical measurements.
 - .2 Excellent long-term stability and quick response time combined with temperature compensation.
 - .3 Sensors shall be available in different enclosures to permit wall or duct mounting or outdoor installation.
- .3 Products:
 - .1 Sensor: Provide humidity sensors as directed with the following minimum specifications:
 - .1 Absolute accuracy of $\pm 2\%$ RH for all sensors.
 - .2 Stainless steel sheath construction completes with integral shroud to enable specified operation in air streams of up to 10m/sec.
 - .3 Maintenance of sensor to be by a simple field method such as solvent or mild detergent solution washing, to remove anticipated airborne contaminants.
 - .4 Duct-mounted sensors shall be located such that the sensing element is between one third and two thirds the distance across the duct interior from any duct wall.
 - .5 Outdoor sensors to be located away from direct sunlight or rain.
 - .6 Sensors shall be unaffected by external transmitters such as walkie-talkies.
 - .7 Filter Type: 60-micron HDPE cover.
 - .8 Operating Humidity: 0-100% RH.
 - .9 Operating Temperature: -40° to 100°C.
 - .10 Inherent Accuracy: <3% RH.
 - .11 Response Time: 10 seconds (11-93% RH), 60 seconds (93-11% RH).
 - .12 Average Temp Coeff.: -0.3% RH/°C.
 - .13 Hysteresis: $\pm 1\%$ RH at 25°C.
 - .14 Calibration: NIST traceable.

- .15 Sensor Construction: Polyelectrolyte polymer resistance type.
- .16 Chemical Resistance: very high.
- .17 Cyclic Aging (25°C): 100 cycles 0-100% RH, <1% shift @ 50% RH.
- .18 Thermal Shock: 140°C (284°F) for six (6) hours <1% shift @ 50% RH.
- .19 Saturation Condition: seven (7) weeks @ 100% RH.
- .20 <2% shift @ 50% RH.
- .21 Ammonia: 100% at 25°C.
- .22 Long-Term Aging: <2% RH after 3+ years.
- .2 Transmitters: As applicable, provide transmitters for all supplied relative humidity sensors, with the following minimum specifications:
 - .1 Output Signal Types (jumper selectable): 4-20 mA, 0-1 VDC, 0-5 VDC, 0-10 VDC (Note: all signals are scaled 0-100% RH.)
 - .2 Output Range Accuracy: <0.5% RH
 - .3 Output Resolution: <0.2% RH (9 bit)
 - .4 Hysteresis: <0.2% RH
 - .5 Temp. Correction Range: -31° to 84°C.
 - .6 Temp. Comp. Sensor: matched thermistor $\pm 0.2^\circ\text{C}$, 0° - 70°C
 - .7 Electronic Accuracy: <1% RH, including temperature compensation, hysteresis, non-linearity.
 - .8 Calibration Accuracy: <0.1% of span
 - .9 Operating Temperature: 0° - 70°C
 - .10 Operating Humidity: 5 – 95% RM (non-condensing).
 - .11 Power Supply: (loop powered) 12-35 VC at unit (3-wire) 24 VAC/dc nominal ($\pm 10\%$).
 - .12 Wiring Connections: screw terminals (14 to 22 AWG).
 - .13 Manufacturing Process: ISO 9002 Certified
 - .14 Optional Temp. Sensor: 1000 ohm. RTD or thermistors.

2.3 PRESSURE TRANSDUCERS

- .1 Provide differential pressure transmitters having the following minimum specifications:
 - .1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, or glycol.
 - .2 Output signal of 4-20 mA into maximum of 1000 ohm load.
 - .3 Output variation of less than 0.2% full scale for supply voltage variations of $\pm 10\%$.
 - .4 Combined non-linearity repeatability and hysteresis effects not to exceed $\pm 0.5\%$ of full-scale output over entire range.
 - .5 External exposed integral zero and span adjustment.
 - .6 Temperature effect of $\pm 1.5\%$ full scale/50°C or less.
 - .7 Output short circuit and open circuit protection.
 - .8 Over-pressure input protection to a minimum of twice rated input.

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- .9 Differential pressure ranges as shown in point schedule.
 - .2 Static Pressure Transmitters:
 - .1 Fan system static pressure sensing unit to be a multipoint element with self-averaging manifold. Maximum pressure loss of 20 mm (.075 in wg) at 1000 M2 (2000 fpm): accuracy of 1% of actual duct static.
 - .2 Output of 4-20 mA linear into maximum of 1000 ohm load.
 - .3 Calibrated Span: not greater than 50% of static pressure at maximum flow.
 - .4 Accuracy: 0.4% of span.
 - .5 Repeatability: within 0.5% of output.
 - .6 Linearity: 1.5% of span.
 - .7 Dead band or Hysteresis: 0.1% of span.
 - .8 External exposed zero and span adjustment.
 - .9 Provide a Dwyer magnehelic gauge to indicate pressure.
 - .3 Velocity Pressure Transmitters:
 - .1 Fan system velocity pressure sensing unit to be a multipoint static and total pressure sensing element with self-averaging manifolds, complete with air equalizer and straightener section assembled as one unit for installation in air duct.
 - .2 Maximum pressure loss 0.15 inch at 2000 ft.min: accuracy of 1% of actual duct velocity.
 - .3 Output of 4-20 mA linear into maximum of 1000 ohm load.
 - .4 Calibrated Span: not greater than 25% of velocity pressure at maximum flow.
 - .5 Calibrated Accuracy: 0.4% of span.
 - .6 Repeatability: within 0.1% of output.
 - .7 Linearity: 0.5% of span.
 - .8 Dead band or Hysteresis: 0.1% of span.
 - .9 External exposed zero and span adjustment.
 - .10 Provide a Dwyer magnehelic gauge to indicate VP.
 - .4 Pressure Switches:
 - .1 Provide pressure or differential pressure switches for ranges as indicated on point schedule.
 - .2 Pressure sensing elements shall be bourdon tube, bellows or diaphragm type.
 - .3 Adjustable set-point and differential.
 - .4 Pressure switches shall be snap action type rated at 120 volts, 15 amps AC or 24 volts DC.
 - .5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.
 - .6 Sensor Ratings: sensors shall have following pressure and accuracy ratings:
 - .1 Hot chilled and condenser water sensors shall be rated at 150% of the system operating pressure.

- .2 Pressure switches for fan operation shall have a range of 0 to 3000 Pa and adjustable differential from 10 to 300 Pa.
- .3 All sensors shall have an isolation valve and snubber installed between the sensor and pressure source.

2.4 CURRENT TRANSDUCER

- .1 Provide current transducers with range indicated on the point schedule and with the following minimum specifications:
 - .1 Current transducers shall measure line current and produce a proportional signal in one of the following ranges:
 - .1 4-20 mA dc,
 - .2 or 0-10 VDC,
 - .3 or 0-5 VDC
 - .2 Direct connection to PC's and other measurement or display devices.
 - .3 Suitable to monitor motors, pumps, conveyors, machine tools, and any electrical load where an analog output is required over a wide range of currents.
 - .4 Suitable for energy management and monitoring.
 - .5 CSA NRTL/C approval (Canada/USA).
 - .6 Factory calibrated to $<\pm 2\%$ FS and can also be easily field calibrated to custom ranges.
 - .7 Capable of monitoring up to 200 amps unless required otherwise.
 - .8 Operating humidity 0 – 95% RH non-condensing
 - .9 Operating temperature -30° to 70°C

2.5 CURRENT SENSING RELAY

- .1 Provide current sensing relay having the following minimum capabilities:
 - .1 Relay to be complete with metering transformer ranged to match load being metered.
 - .2 Direct connection to PCs for general status monitoring.
 - .3 Directly controls AC or DC loads, such as relays and lamps, in response to the current of a monitored AC circuit.
 - .4 Suitable for use in safety and alarm circuits and monitors motors, heaters, etc.
 - .5 CSA NRTL/C approval (Canada/USA).
 - .6 Integral zero-leakage LED's to indicate sensor power and also switch status, which operates when the current level sensed by the integral current transformer exceeds the threshold value as set.
 - .7 Certified to CSA, NRTL/C standards.
 - .8 Operating temperature 0 – 70°C (32° to 158°F).
 - .9 Trip set-point: adjustable multi-turn pot over full detection range, GnG fixed at input one (1) minute.
 - .10 Hysteresis: $<1\%$ FS maximum.
 - .11 Operating humidity 0 – 95% RH non-condensing.

- .12 Integral relay shall be provided with plug in base and shorting shunt (if required) to protect current transformer when relay is removed from socket. Current transformer shall be available for single or three-phase metering into single relay.
- .13 Current relay shall have adjustable latch level, adjustable delay on latch and a minimum differential of 10% of latch setting between latch level and release level.
- .14 Three-phase application shall provide for discrimination between phases to allow detection of worst-case selection. Current relay shall be powered from control circuit of motor starter being metered and shall be suitable for mounting in the motor starter cabinet.
- .15 Relay contacts shall be capable of handling five (5) amps at 240 Vac loads.

2.6 ELECTRIC RELAYS

- .1 Provide double voltage DPDT relays for control and status indication of alarms and/or electrical starters and equipment where shown on point schedule.
- .2 Relay coils shall be rated for 120 V or 24 V. Where other voltages occur provide transformer.
- .3 Contacts rated at 5 amps at 120 V AC.
- .4 Relays to be plug-in type with termination base.

2.7 DAMPER OPERATORS ELECTRONIC

- .1 Provide push-pull type electronic proportional damper operators.
- .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as directed by Project Engineer.
- .3 Size operators to control dampers against maximum pressure or dynamic closing pressure whichever is greater.
- .4 Power requirements are 5 VA maximum at 24 V AC.
- .5 Operating range is 0-20 V DC.
- .6 Operating speed and torque to match application and will be subject to Departmental Representative's approval.

2.8 CONTROL VALVES

- .1 Control valves shall be external to unit.
- .2 Control valves are existing three-way valve to reused for new AHU-7 and AHU-8.

2.9 WATER DETECTOR

- .1 Provide a water detector that allows for wiring to be opened or closed, powered by a set relay contacts and will determine leak detection, internal malfunction and power loss sensor. Acceptable Material: Greystone WD-10.
 - .1 Specifications:
 - .1 Power Requirements: 12-32 VAC or VDC.

- .2 Power Consumption at 12 VDC: 427 mW.
- .3 Operating Temperature: 0°C to 70°C.
- .4 Enclosure: gold-plated probes, adjustable legs, epoxy paint.
- .5 Alarm output: Form C non-powered, rated at 120 VAC/2 amps.
- .6 Supervisory Circuitry: Yes.
- .7 Reverse Acting Contacts: Yes.
- .8 Reverse Voltage Protection: Yes
- .9 Internal Voltage Regulation: Yes
- .10 RFI/EMI Noise Immunity: Yes

2.10 ANALOG TO PULSE (ATP) TRANSDUCERS

- .1 Provide ATPs to convert an analog signal into a digital pulse output signal with user selectable eight standard analog input ranges to the ATP by changing jumper shunt positions. The ATP shall be provided with two timing modes, standard and custom selectable and shall meet the following minimum specifications:
 - .1 Supply Voltage: 24 VAC or VDC.
 - .2 Analog Input:
 - .1 Voltage/Impedance 0-15 VDC/1m.
 - .2 Supply Current 0-20 mA/250.
 - .3 Digital Output:
 - .1 Form "C" Relay 1 amp @ 24 volts
 - .2 Electrical Life 100,000 @ 1 amp
 - .3 Mechanical Life 10 million operations
 - .4 Environmental:
 - .1 Operating Temperature -20° to 150°F
 - .2 Operating Humidity 10 to 95% non-condensing

Part 3 Executions

3.1 GENERAL

- .1 Provide all remote sensing points and instrumentation as indicated and/or required for the complete operational capability of the Energy Monitoring and Control System.
- .2 All equipment shall be installed according to manufacturers' published instructions.
- .3 All controls scope of work related to this project shall be carried out by Johnson Controls Canada LP.

3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 All sensors shall be stabilized to such a level as to permit on-the-job installations that will require minimum field adjustments or calibration.

- .2 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.
- .3 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces. The location shall be within the vibration and velocity limits of the sensor. Where an extended surface element is required to properly sense the average temperature it shall be securely mounted within the duct to measure the best average temperatures. Elements shall be thermally isolated from brackets and supports to respond to air temperature only. Sensor element to be supported separately and not connected to coils or filter racks.
- .4 Wells shall be installed for all piping installations. Where pipe diameter is less than the insertion length of the well, the well shall be installed at an elbow location to affect proper flow across the entire well area. The well, when installed, shall not restrict flow in piping by more than 30% (i.e., the well shall not represent more than 30% of the pipe as measured on a cross section by area).
- .5 Room temperature and humidity sensors are existing to remain and to be reintegrated to new control system.

3.3 TRANSMITTERS

- .1 Temperature transmitters, humidity transmitters, current to pneumatic transducers, solenoid air valves, controllers, and relays to be installed in NEMA 4X enclosures.
- .2 Panels to be either free-standing or wall-mounted enamelled steel cabinets with hinged and key-locked front door. Arrange for conduit and tubing entry from top, bottom, or either side.
- .3 Panels shall be modular multiple panels being used if required for capacity in any particular location. They shall handle all requirements with space to accommodate an additional 20% without adding further cabinets.
- .4 All panels shall be lockable with the same key.
- .5 All wiring and tubing within panels to be located in trays or individually clipped to back of panel, and clearly identified.
- .6 Field-mounted transmitters and sensors to be properly supported on pipe stands or channel brackets, all wall-mounted devices to be mounted on plywood panel properly attached to the wall.
- .7 All field devices to be properly identified.
- .8 Flow measuring stations to be capped until ducts are cleaned.

3.4 TESTING

- .1 All devices shall be properly calibrated and tested for performance and accuracy. A report detailing test performed and results to be submitted to the Departmental Representative for approval. The Departmental Representative will verify results at random. Provide all testing equipment necessary. Provide manpower necessary to assist in verification.

- .2 Submit samples at random from equipment shipped, before installation, as requested by the Departmental Representative for testing by the Departmental Representative or an independent agency. Devices not meeting performance and accuracy specified shall be replaced by proper equipment at the Contractor's expense.
- .3 Refer to Section 01 00 10 – General Instructions, for detailed testing requirements of static and velocity transmitters.

Part 4 SEQUENCE OF OPERATION:

4.1 GENERAL

- .1 AHU-7 & AHU-8 are designed to serve Bay 3 cleanroom.
- .2 For the purpose of this project AHU-7 and AHU-8 are intended to have local controllers and controls, supplied and installed under this contract and integrated to the building EMCS/BAS system.
- .3 AHU-7 & AHU-8 are intended to be fully redundant units but to have the options of running both at the same time under limited fan capacity. When both units are in operation the fan capacity of both units shall be soft limited by interlock between each unit and modulate to maintain the main supply header, ductwork static pressure setpoint. Soft limits for both unit operation shall be set during TAB. During normal mode the runtime on AHU-7 and AHU-8 shall be equal based on a weekly schedule.
- .4 AHU-7 & AHU-8 shall never be started at the same time. Startup of each unit shall be performed in a sequential start even when both units are to operate and shall be soft started.

4.2 LOCAL CONTROLS

- .1 Local controls are to be provided to permit the programming, setting of set points, sequencing, and full operation (including scheduling) of each unit without the requirement for connection to the BAS system. If BAS system fails units shall operate with last setpoints and sequence of operation.

4.3 BUILDING AUTOMATION SYSTEM INTERFACE

- .1 The Building Automation System (BAS) shall be able to read/write and read only points to be able to adjust unit operation and setpoints from operator workstation and to trouble shoot unit through BAS graphics.
- .2 If a BAS is not present, or communication is lost with the BAS the local controller shall operate using last setpoints.
- .3 BAS shall sequence each AHU on/off depending on space occupancy status and if one unit has failed the back up AHU shall be started.

4.4 OCCUPIED

- .1 During occupied periods, the supply and return fan shall run continuously and the outside air damper shall open to maintain minimum ventilation requirements. The chilled water and hot water valves shall modulate to maintain the discharge air temperature setpoint. If economizing is enabled the outside air damper shall also modulate to maintain the

discharge air temperature setpoint. If the discharge air temperature sensor fails, the chilled water and hot water valves shall close, and an alarm shall be annunciated at the BAS.

4.5 UNOCCUPIED

- .1 When the space temperature is below the unoccupied heating setpoint of 18.0°C (adj.) the supply and return fan shall start, the outside air damper shall remain closed and the hot water valve shall open. When the space temperature rises above the unoccupied heating setpoint of 18.0°C (adj.) plus the unoccupied differential of 2.0°C (adj.) the supply and return fan shall stop and the hot water valve shall close. When the space temperature is above the unoccupied cooling setpoint of 27.0 °C (adj.) the supply and return fan shall start, the outside air damper shall open if economizing is enabled and remain closed if economizing is disabled and the chilled water valve shall open. When the space temperature falls below the unoccupied cooling setpoint of 27.0°C (adj.) minus the unoccupied differential of 2.0°C (adj.) the supply and return fan shall stop, the chilled water valve shall close and the outside air damper shall close.

4.6 OPTIMAL START

- .1 The BAS shall monitor the scheduled occupied time, occupied space setpoints and space temperature to calculate when the optimal start occurs.
- .2 BAS shall sequence start up time of units with other units on system to reduce incoming current.

4.7 MORNING WARM-UP MODE

- .1 During optimal start, if the average space temperature is below the occupied heating setpoint a morning warm-up mode shall be activated. When morning warm-up is initiated the unit shall enable the heating and supply fan. The outside air damper shall remain closed. When the space temperature reaches the occupied heating setpoint (adj.), the unit shall transition to the occupied mode.

4.8 PRE-COOL MODE

- .1 During optimal start, if the average space temperature is above the occupied cooling setpoint, pre-cool mode shall be activated. When pre-cool is initiated the unit shall enable the fan and cooling or economizer. The outside air damper shall remain closed, unless economizing. When the space temperature reaches occupied cooling setpoint (adj.), the unit shall transition to the occupied mode.

4.9 OPTIMAL STOP

- .1 The BAS shall monitor the scheduled unoccupied time, occupied setpoints and space temperature to calculate when the optimal stop occurs. When the optimal stop mode is active the unit controller shall maintain the space temperature to the space temperature offset setpoint. Outside air damper shall remain enabled to provide minimum ventilation.

4.10 OCCUPIED BYPASS

- .1 The BAS shall monitor the status of the “on” and “cancel” buttons of the space temperature sensors. When an occupied bypass request is received from a space sensor,

the unit shall transition from its current occupancy mode to occupied bypass mode and the unit shall maintain the space temperature to the occupied setpoints (adj.).

4.11 ECONOMIZER

- .1 The discharge air temperature sensor shall measure the dry bulb temperature of the air leaving the cooling coil while economizing. When economizing is enabled and the unit is operating in the cooling mode, the economizer damper shall be modulated between its minimum position and 100% to maintain the discharge air temperature setpoint. The economizer damper shall modulate toward minimum position in the event the mixed air temperature falls below the low temperature limit setting. Reference Enthalpy: Outside air (OA) enthalpy shall compare with the reference enthalpy control setpoint. The economizer shall enable when OA enthalpy is 2.0 BTU/LB less than enthalpy control setpoint. The economizer shall disable when OA enthalpy is greater than enthalpy control setpoint.

4.12 SUPPLY FAN

- .1 The fan shall be off in the unoccupied mode. When the unit controller is in the occupied mode, the supply fan shall operate continuously and its VFD speed shall be modulated to maintain the duct static pressure setpoint or 200 Pa (adj.) to be set during TAB.
- .2 If the supply fan fails to prove status for 30 seconds (adj.), the fan shall be commanded off, the outside air damper shall close, all valves shall close, and an alarm will be annunciated at the BAS. A manual reset shall be required to restart the fan. A hardwired, high static pressure cut-off switch shall be electrically interlocked with the variable speed drive. If the high static pressure cut-off switch is tripped the fan shall stop, the outside air damper shall close, all valves shall close, and an alarm will be annunciated at the BAS. A manual reset of the high static pressure cut-off switch shall be required to restart the fan.
- .3 Fan inlet probes shall provide supply fan airflow.

4.13 RETURN FAN

- .1 The return fan shall be off in the unoccupied mode. When the controller is in the occupied mode, the return fan shall operate continuously and modulate the VFD to maintain the return plenum static pressure setpoint of 200 Pa (adj.), to be set during TAB.
- .2 If the return fan fails to prove status for 30 seconds (adj.), the fan shall be commanded off, the outside air damper shall close, all valves shall close, and an alarm shall be annunciated at the BAS. A manual reset is required to restart the fan. A hardwired, high static pressure cut-off switch is electrically interlocked with the variable speed drive. If the high static pressure cut-off switch is tripped, the fan shall stop, the outside air damper shall close, and all valves shall close, and an alarm shall be annunciated at the BAS. A manual reset of the high static pressure cut-off switch shall be required to restart the fan. Supply and return fans are interlocked via software, a failure of either shall disable both.

4.14 BUILDING PRESSURE CONTROL

- .1 A differential pressure transducer shall actively monitor the difference in pressure between the building bay 3 (indoors) and outdoors. If the building pressure increases above the desired setpoint of 10 Pa (adj.), the AHU controller shall modulate the relief air damper and mixed air damper to control building pressure at setpoint. If the building

pressure decreases below the desired setpoint and relief air damper is closed, then controller shall modulate the outdoor air damper open to maintain setpoint.

4.15 MIXED AIR LOW LIMIT

- .1 The initial damper opening rate shall be limited to 2% per minute (adj.) until the damper has reached its minimum ventilation position. The outside air damper shall modulate to a position less than the minimum damper position if the mixed air temperature drops below 10.0°C (adj.). If the mixed air temperature sensor fails an alarm shall be annunciated at the BAS and the outside air damper shall return to the minimum position.

4.16 FREEZE PROTECTION

- .1 A hardwired, low limit temperature switch shall be electrically interlocked with the variable speed drive. If the low limit temperature switch is tripped 4°C (adj.), the outside air damper shall close, hot water heating valves shall open to 100% (adjust per climate) and an alarm shall be annunciated at the BAS. Chilled water valves shall modulate closed. All unit dampers shall modulate closed, except the mixed air damper that shall be open. A manual reset of the low limit temperature switch shall be required to restart the fan.

4.17 FILTER STATUS

- .1 A differential pressure switch shall monitor the differential pressure across the different filter banks, pre-filter separates then final and separate than HEPA filters when the fan is running. If the switch closes during normal operation a dirty filter alarm shall be annunciated at the BAS.

4.18 DEHUMIDIFICATION

- .1 When the chilled water system is in operation and the outdoor air enthalpy is higher than return air enthalpy (economizer sequence) and when average zone humidity is 1% above set point and zone temperature is at set point. Chilled water valve shall be fully enabled to the coil and coil bypass damper (MD-1) shall modulate from closed position to bypass air around cooling coil to maintain humidity setpoint. If room humidity set point is not achieved with a predetermined time frame (45 minutes) close the F/A damper fully. If humidity set point is not still achieved (15 minutes later), abort the dehumidification sequence and resume normal operation, provide an alarm at the BAS. If space thermal conditions are still within specification, the dehumidification function may continue for a longer period of time.
- .2 When chilled water systems are shutdown, or the outside air enthalpy is lower than return air enthalpy (economizer sequence) and when average zone humidity is 1% above set point and zone temperature is at set point. Modulate the economizer dampers from current position to maintain humidity setpoint. If room humidity set point is not achieved with a predetermined time frame (45 minutes) reset/release humidity economizer sequence and revert back to original. If humidity set point is not still achieved (15 minutes later), abort the dehumidification sequence and resume normal operation, provide an alarm at the BAS. If space thermal conditions are still within specification, the dehumidification function may continue for a longer period of time.

4.19 FIRE ALARM/SMOKE CONTAINMENT MODE (2ND STAGE SIGNAL)

- .1 BAS is connected to fire alarm system for signal only. Fire Alarm sequence of operation listed below is to be programmed and activated by the local controller.
- .2 AHU goes to Fire Alarm/Smoke Containment Mode to create a negative pressure in the alarmed zone, relative to adjacent zones.
- .3 AHU-7 and AHU-8 to be off. All dampers on AHU-7 and AHU-8 to fully close.
- .4 R/F ON at 25% of max capacity (adj.).
- .5 Activate smoke exhaust fans in Bay 3.

4.20 SMOKE EVACUATION MODE – CHANGES FROM OCCUPIED MODE

- .1 BAS is connected to fire alarm system for signal only. Fire Alarm sequence of operation listed below is to be programmed and activated by the local controller.
- .2 Upon activation of the local zone key switch, unit will operate in the Smoke Evacuation Mode.
- .3 R/A damper (MD-1) and B/A damper (MD-4) fully closed.
- .4 F/A damper (MD-2) fully open.
- .5 E/A damper (MD-3) open, outside air volume to be 2360 L/s.
- .6 S/F and R/F ON.
- .7 Heating coil controlled for 13°C make-up air temperature.
- .8 Upon deactivation of the local zone key switch, normal scheduled occupied or unoccupied mode will resume.
- .9 Activate smoke exhaust fans in Bay 3.

4.21 FIRE ALARM INTERFACE

- .1 EMCS shall be interlocked with fire alarm panel through a digital input signal.
- .2 The AHU serves a designated fire/smoke zone. The two-stage fire alarm panel shall issue a second stage alarm signal to the zone under fire/smoke condition and a first stage signal to the remaining zones.
- .3 A zone in second stage fire must have the AHU to go into Fire Alarm/Smoke Containment Mode to maintain negative zone pressurization relative to adjacent zones. All adjacent zones in first stage fire alarm shall continue to operate normally until receiving a second stage alarm.
- .4 Wire and provide keyed exhaust fan switch in Bay 3 next to Gridline 12/F at ground level next to existing switch.
- .5 When the fire alarm panel has been reset (i.e. the fire extinguished), a manual override keyed switch located in the space shall permit the fire authority to put the designated zone HVAC equipment in a Smoke Evacuation Mode to permit smoke evacuation. When the keyed switch is returned back to the OFF position (of after 30 minutes), the AHU shall resume normal operation.

- .6 Contractor will provide the signal and necessary contacts in the vicinity of the air handling equipment. Co-ordinate work as necessary for proper operation the keyed switch is returned back to the OFF position (of after 30 minutes), the AHU shall resume normal operation.

4.22 AUTOMATIC RESTART SEQUENCE

- .1 EMCS shall automatically restart AHU-5 in sequence with existing air handlers (1-minute lag between starting of each unit), during initial start-up, scheduled start-up, fire alarm reset, or power failure restart.
- .2 Alarms shall be suppressed during systems start-up, until systems operation has stabilized.

4.23 EMERGENCY POWER SYSTEMS OPERATION

- .1 When emergency power system is activated, EMCS shall automatically restart all systems, connected to emergency power, in sequence. If the generator fails or upon a power glitch, when normal power is resumed start AHUs in sequence according to their designation number with a delay to avoid power demand penalty.

4.24 HUMIDIFICATION

- .1 When average zone humidity is 1% below set point and zone temperature is at set point. Controller shall energize associated humidifier and open control valve associated to operating AHU. Modulate humidifier output to maintain space humidity setpoint.
- .2 Monitor humidifier and report any alarms.

4.25 CO2 DEMAND CONTROLLED VENTILATION

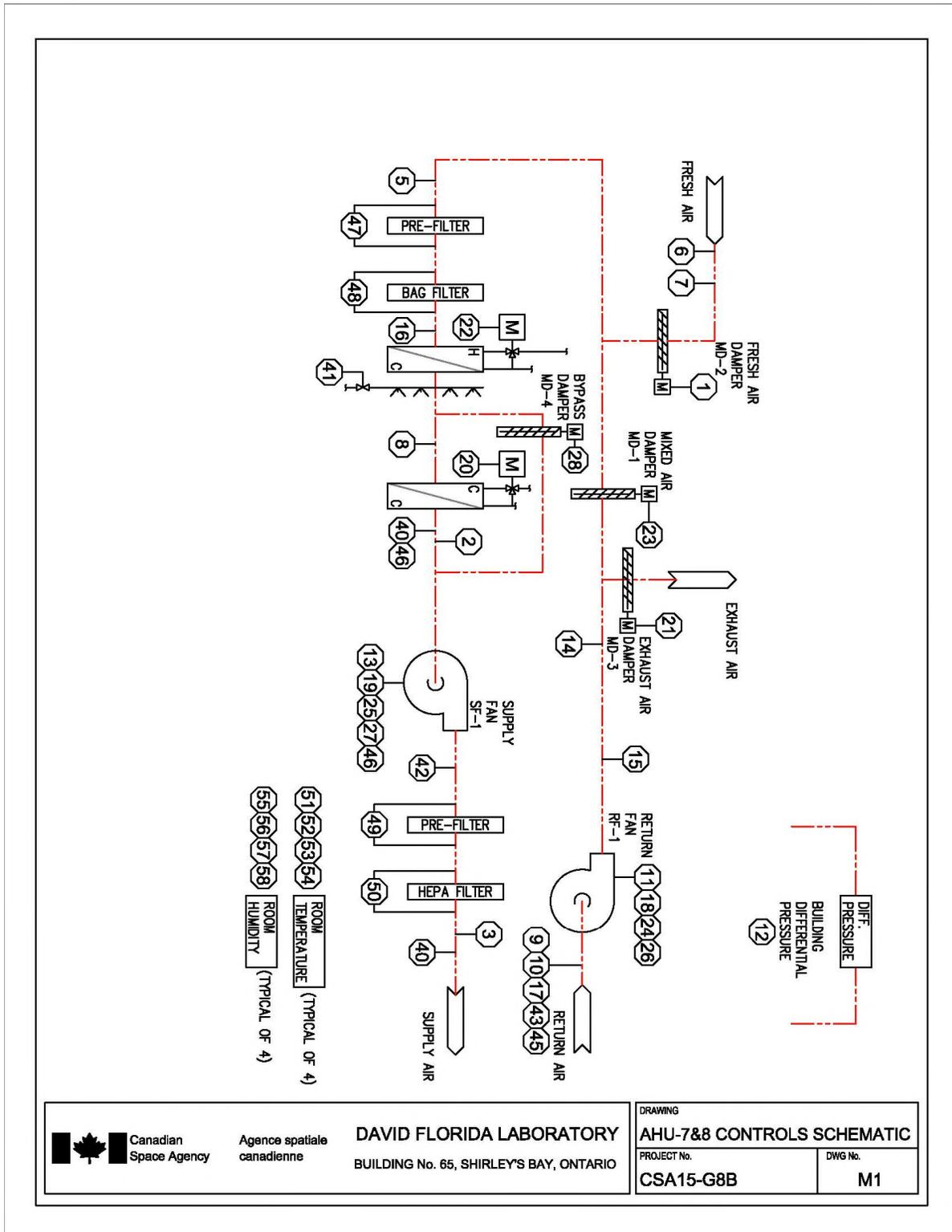
- .1 AHU-7 and AHU-8 shall not modulate outdoor air damper based on CO2.
- .2 Controller shall monitor CO2 on return air duct for BAS graphics and alarm should CO2 levels be above 800 ppm (adj.)

4.26 UNOCCUPIED MIXED AIR PLENUM TEMPERAURE

- .1 When AHU-7 or AHU-8 are off, BAS shall modulate the heating control valve to maintain a mixed air plenum temperature of 18°C (adj.).

Part 5 APPENDIX

| AHU - 7 & 8 UC600 - 1 FLOW - SYSTEM POINTS LIST | | | | | | | | | | | | | | | | | |
|--|---|------------|----------------|-----------------|----------------|--------------------|----------|---------|---------------|-------------------|------------------|--------|------------------|-------------|--------------------|-----------------------------------|--------|
| CONTROLLER: UC600 | | POINT TYPE | | | | | | | | | | ALARMS | | | | | |
| TAG | SYSTEM POINT DESCRIPTION | GRAPHICS | HARDWARE INPUT | HARDWARE OUTPUT | SOFTWARE POINT | HARDWARE INTERLOCK | WIRELESS | NETWORK | DEFAULT VALUE | HIGH ANALOG LIMIT | LOW ANALOG LIMIT | BINARY | LATCH DIAGNOSTIC | SENSOR FAIL | COMMUNICATION FAIL | DIAGNOSTICS | NOTES |
| 1 | FRESH AIR DAMPER | X | AI | AO | | | | | | | | | | | | | |
| 2 | COOLING COIL LEAVING TEMPERATURE | X | AI | | | | | | | X | X | | | X | | SENSOR FAILURE | |
| 3 | DISCHARGE AIR TEMPERATURE | X | AI | | | | | | | X | X | | | X | | SENSOR FAILURE | |
| 4 | DUCT STATIC PRESSURE | X | AI | | | | | | | | | | | X | | SENSOR FAILURE | |
| 5 | MIXED AIR TEMPERATURE | X | AI | | | | | | | X | X | | | X | | SENSOR FAILURE | |
| 6 | OUTDOOR AIR RELATIVE HUMIDITY | X | AI | | | | | | | | | | | | | | |
| 7 | OUTDOOR AIR TEMPERATURE | X | AI | | | | | | | | | | | | | | |
| 8 | HEATING COIL LEAVING TEMPERATURE | X | AI | | | | | | | X | X | | | X | | SENSOR FAILURE | |
| 9 | RETURN AIR CO2 | X | AI | | | | | | | X | | | X | | | CO2 SENSOR FAILURE | |
| 10 | RETURN AIR TEMPERATURE | X | AI | | | | | | | X | X | | | X | | SENSOR FAILURE | |
| 11 | RETURN FAN AIR FLOW | X | AI | | | | | | | | | | | | | | |
| 12 | SPACE STATIC PRESSURE | X | AI | | | | | | | X | X | | | X | | SENSOR FAILURE | |
| 13 | SUPPLY FAN AIR FLOW | X | AI | | | | | | | | | | | | | | |
| 14 | RETURN PLENUM STATIC | X | AI | | | | | | | | | | | | | | |
| 15 | RETURN HIGH/LOW STATIC ALARM | X | BI | | | X | | | | | | X | X | | | DUCT STATIC PRESSURE HIGH/LOW | NOTE 1 |
| 16 | LOW LIMIT TEMPERATURE CUTOFF | X | BI | | | X | | | | | | X | X | | | LOW TEMP DETECT | NOTE 1 |
| 17 | RETURN FAN STATIC ALARM | X | BI | | | X | | | | | | X | X | | | DUCT STATIC PRESSURE HIGH/LOW | NOTE 1 |
| 18 | RETURN FAN STATUS | X | BI | | | | | | | | | X | | | | FAN FAILURE | |
| 19 | SUPPLY FAN STATUS | X | BI | | | | | | | | | X | | | | FAN FAILURE | |
| 20 | CHILLED WATER COIL VALVE COMMAND OUTPUT | X | AI | AO | | | | | | | | | | | | | |
| 21 | EXHAUST AIR DAMPER COMMAND | X | AI | AO | | | | | | | | | | | | | |
| 22 | HEATING COMMAND OUTPUT | X | AI | AO | | | | | | | | | | | | | |
| 23 | MIXED AIR DAMPER | X | AI | AO | | | | | | | | | | | | | |
| 24 | RETURN FAN VFD SPEED COMMAND | X | AI | AO | | | | | | | | | | | | | |
| 25 | SUPPLY FAN VFD SPEED COMMAND | X | AI | AO | | | | | | | | | | | | | |
| 26 | RETURN FAN VFD START STOP COMMAND | X | | BO | | | | | | | | | | | | | |
| 27 | SUPPLY FAN VFD START STOP COMMAND | X | | BO | | | | | | | | | | | | | |
| 28 | COOLING COIL BYPASS DAMPER | X | AI | BO | | | | | | | | | | | | | |
| 29 | OCCUPIED COOLING SETPOINT | X | | | X | | | | 74.0 deg. F | | | | | | | | |
| 30 | OCCUPIED HEATING SETPOINT | X | | | X | | | | 70.0 deg. F | | | | | | | | |
| 31 | OCCUPIED STANDBY COOLING SETPOINT | X | | | X | | | | 80.0 deg. F | | | | | | | | |
| 32 | OCCUPIED STANDBY HEATING SETPOINT | X | | | X | | | | 65.0 deg. F | | | | | | | | |
| 33 | UNOCCUPIED COOLING SETPOINT | X | | | X | | | | 85.0 deg. F | | | | | | | | |
| 34 | UNOCCUPIED HEATING SETPOINT | X | | | X | | | | 60.0 deg. F | | | | | | | | |
| 35 | OCCUPIED BYPASS TIMER | X | | | X | | | | 2.0 HOURS | | | | | | | | |
| 36 | DISCHARGE AIR TEMPERING SETPOINT | X | | | X | | | | 55.0 deg. F | X | X | | | X | | | |
| 37 | DISCHARGE AIR TEMPERATURE CONTROL POINTS | X | | | X | | | | | | | | | | | | |
| 38 | BAS COMMUNICATION STATE | X | | | X | | | | | | | | | X | | | NOTE 2 |
| 39 | MAINTENANCE REQUIRED | X | | | X | | | | 600 HOURS | | | | | | | | |
| 40 | DISCHARGE AIR HUMIDITY | X | AI | | | | | | | | | | | | | | |
| 41 | HUMIDIFIER SELECTOR VALVE | X | AI | AO | | | | | | | | | | | | TWO POSITION ON/OFF W/ END SWITCH | |
| 42 | SUPPLY HIGH/LOW STATIC ALARM | X | BI | | | X | | | | | | X | X | | | DUCT STATIC PRESSURE HIGH/LOW | NOTE 1 |
| 43 | RETURN FAN VFD FEEDBACK | X | AI | | | | | | | X | X | | | X | | | |
| 44 | SUPPLY FAN VFD FEEDBACK | X | AI | | | | | | | X | X | | | X | | | |
| 45 | RETURN AIR HUMIDITY | X | AI | | | | | | | | | | | | | | |
| 46 | COOLING COIL DISCHARGE AIR TEMPERATURE | X | AI | | | | | | | | | | | | | | |
| 47 | PRE-FILTER DIFFERENTIAL PRESSURE AND ALARM | X | AI | | | | | | | X | X | | | X | | | |
| 48 | BAG FILTER DIFFERENTIAL PRESSURE AND ALARM | X | AI | | | | | | | X | X | | | X | | | |
| 49 | HEPA PRE-FILTER DIFFERENTIAL PRESSURE AND ALARM | X | AI | | | | | | | X | X | | | X | | | |
| 50 | HEPA FILTER DIFFERENTIAL PRESSURE AND ALARM | X | AI | | | | | | | X | X | | | X | | | |
| 51 | ROOM TEMPERATURE SENSOR | X | AI | | | | | | | | | | | | | | |
| 52 | ROOM TEMPERATURE SENSOR | X | AI | | | | | | | | | | | | | | |
| 53 | ROOM TEMPERATURE SENSOR | X | AI | | | | | | | | | | | | | | |
| 54 | ROOM TEMPERATURE SENSOR | X | AI | | | | | | | | | | | | | | |
| 55 | ROOM HUMIDITY SENSOR | X | AI | | | | | | | | | | | | | | |
| 56 | ROOM HUMIDITY SENSOR | X | AI | | | | | | | | | | | | | | |
| 57 | ROOM HUMIDITY SENSOR | X | AI | | | | | | | | | | | | | | |
| 58 | ROOM HUMIDITY SENSOR | X | AI | | | | | | | | | | | | | | |
| 59 | HUMIDIFIER START/STOP | X | | BO | | | | | | | | X | | | | | |
| 60 | HUMIDIFIER STATUS | X | BI | | | | | | | | | X | | | | | |
| 61 | HUMIDIFIER OUTPUT | X | | AO | | | | | | | | | | | | | |
| 62 | HUMIDIFIER ALARM | X | BI | | | | | | | | | X | | | | | |
| CONTROLLER SPARE HARDWARE POINTS | | | | | | | | | | | | | | | | | |
| UNIVERSAL INPUT(S) | | 6 | | | | | | | | | | | | | | | |
| ANALOG OUTPUT(S) | | 5 | | | | | | | | | | | | | | | |
| BINARY OUTPUT(S) | | 2 | | | | | | | | | | | | | | | |
| GENERAL NOTES | | | | | | | | | | | | | | | | | |
| 1. DEVICE IS HARDWARE INTERLOCKED, MANUAL RESET MAY BE REQUIRED. | | | | | | | | | | | | | | | | | |
| 2. DISPLAYED AT THE BAS USER INTERFACE IF PRESENT. | | | | | | | | | | | | | | | | | |
| 3. ALL ANALOG SETPOINTS SHALL BE ADJUSTABLE AT USER INTERFACE. | | | | | | | | | | | | | | | | | |



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|--|---|-------------------------------|---|
| <p>Canadian Space Agency Agence spatiale canadienne</p> | <p>DAVID FLORIDA LABORATORY BUILDING No. 65, SHIRLEY'S BAY, ONTARIO</p> | | <p>DRAWING AHU-7&8 CONTROLS SCHEMATIC</p> |
| | <p>PROJECT No. CSA15-G8B</p> | <p>DWG No. M1</p> | |

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 This section covers items common to all sections of Division 26, and 28.
- .2 Coordinate location and installation of all equipment with all trades to ensure the equipment with all trades to ensure the equipment is serviceable.
- .3 The word “provide” shall mean “supply and install”.

1.2 REFERENCES

- .1 Provide complete installation in accordance with the latest edition of the Ontario Electrical Safety Code and Electrical Bulletins.
- .2 Comply with the following additional codes as a minimum:
 - .1 CSA Standards.
 - .2 ULC Standards.
 - .3 Ontario Building Code – Latest Edition.
 - .4 National Building Code.
 - .5 Fire Code.
 - .6 NFPA.

1.3 DEFINITIONS

- .1 Inspection authorities shall mean Electrical Safety Authority.
- .2 Supply authority shall mean Hydro Ottawa.
- .3 Provide shall mean supply, install, test and commission.

1.4 DESIGN REQUIREMENTS

- .1 Operating voltages to: CAN3-C235-83.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .3 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .4 Language operating requirements: provide identification nameplates and labels for control items in English and French.
- .5 Use one nameplate or label for each language.

1.5 CARE, OPERATION AND START-UP

- .1 Instruct Departmental Representative and operating personnel in the operation, care and maintenance of systems, system equipment and components.
 - .2 Arrange and pay for services of manufacturer’s factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
-

- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

1.6 TIME AND COMPLETION

- .1 Commence work upon notification of acceptance of offer, or as outlined in the approved construction schedule.
- .2 Verify equipment delivery times immediately and notify Departmental Representative within two (2) weeks of contract award of any deliveries which would affect schedule.

1.7 FIRE AND SAFETY REQUIREMENTS

- .1 Comply with National Building Code (Part 8, Health and Safety Measures at Construction and Demolition Sites) and Provincial Regulations for Construction Projects.

1.8 EXISTING SERVICES

- .1 Existing services required for work may be used by the Contractor with the Departmental Representative's written consent. Ensure capacity is adequate prior to imposing additional loads. Connect and disconnect at own expense and responsibility.
- .2 Notify the Departmental Representative a minimum of 72 hours in advance of intended interruption of services; obtain requisite permissions.
- .3 Keep duration of these interruptions to a minimum. Carry out all interruptions during silent hours or as approved by the Departmental Representative in writing.
- .4 Any unscheduled disruption to services to be immediately reinstated.
- .5 Existing fire alarm and security systems are to remain fully functional, throughout, provide conduit and wire as required to maintain services during construction.

1.9 DEMOLITION

- .1 Disconnect and make safe all systems to be demolished by other Divisions. Refer to other Divisions for extent.
- .2 Maintain existing remaining circuits, systems, etc., which pass through construction/demolition areas. Provide additional wire and conduit as required to maintain systems. Additional wire and conduit to be concealed when construction is completed.
- .3 Reinstate immediately, any existing remaining systems, inadvertently interrupted during construction or demolition.
- .4 Remove all redundant wiring and conduit in ceiling spaces, (i.e. power.).

1.10 PROTECTION

- .1 Protect access areas through existing building (lobby, elevator, corridor stairwell, etc.) from damage. Clean area daily or more frequently if directed by Departmental Representative.
-

- .2 Protect exterior areas (roof, walls, etc.) against damage during handling of new and removed materials.
- .3 Repair and make good all damaged equipment, etc. to satisfaction of the Departmental Representative.
- .4 Protect stored materials; work in process and finished work against damage until take-over.
- .5 Protect adjacent areas against spread of dust and dirt beyond work areas.
- .6 Protect operatives and other users of site from all hazards.

1.11 CUTTING, PATCHING AND MAKING GOOD

- .1 Provide cutting and patching of existing surfaces as required to accommodate new work.
- .2 Remove all items so shown or specified.
- .3 Patch and make good surfaces cut, damaged or disturbed, to Departmental Representative's approval. Match existing material, colour, finish and texture or as indicated otherwise.
- .4 Provide dust tight screens or partitions to localize dust generating activities and for protection of finished areas of work, workers and public.
- .5 Scan slabs before coring or drilling deeper than 25 mm. Provide all required notification, clearance and protection for scanning process. Adjust coring and drilling locations as necessary to avoid rebar and conduits.

1.12 CO-ORDINATION

- .1 Coordinate the work with all other Divisions, especially Divisions 21, 23 and 25, to ensure systems compatibility, and to ensure schedules and requirements are maintained.
- .2 Where perceived interferences occur, prepare detailed sketches indicating proposed solution for review and acceptance by Departmental Representative.
- .3 The contract documents are intended to describe complete fully functional systems although not all components are indicated. Division 26 shall provide all required conduits, wiring, equipment, etc. to provide fully functional systems which meet the design intent.

1.13 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
 - .2 Pay associated fees.
 - .3 Notify Departmental Representative of changes required by Electrical Inspection Department prior to making changes.
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- .4 Furnish Certificates of Acceptance from Electrical Inspection Department and authorities having jurisdiction on completion of work to Departmental Representative and include in manuals. Final payment will not be made until certificates have been submitted.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Equipment and material to be new CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.
- .3 Factory-assemble control panels and component assemblies.

2.2 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
- .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with self-tapping screws.

| Nameplate | Sizes | | |
|-----------|-------------|---------|--------------------|
| Size 1 | 10 x 50 mm | 1 line | 3mm high letters |
| Size 2 | 12 x 70 mm | 1 line | 5 mm high letters |
| Size 3 | 12 x 70 mm | 2 lines | 3 mm high letters |
| Size 4 | 20 x 90 mm | 1 line | 8 mm high letters |
| Size 5 | 20 x 90 mm | 2 lines | 5 mm high letters |
| Size 6 | 25 x 100 mm | 1 line | 12 mm high letters |
| Size 7 | 25 x 100 mm | 2 lines | 6 mm high letters |

- .2 Labels: electronically printed, self-adhesive plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels:
- .1 To indicate volts, phase, amps, HP, etc.
- .2 To be submitted to Departmental Representative prior to manufacture for approval.
- .4 Allow for average of twenty-five (25) letters per nameplate.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters, contactors and variable frequency drives: indicate equipment being controlled and voltage, Size 3.
- .7 Terminal cabinets and pull boxes: indicate system and voltage, Size 3.
-

- .8 All circuit protective devices to be c/w a lamicoïd label mounted inside door of device listing all fuse type and ratings, circuit breaker settings and minimum interrupting ratings.

2.3 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1.

2.4 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape at points where conduit or cable enters wall, ceiling, or floor, and at 6 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

| | Prime | Auxiliary |
|-------------------|--------|-----------|
| 120/208 V | Blue | |
| 120/240 V | Grey | |
| 277/480 V | Black | |
| 347/600 V | Purple | |
| Grounding | Brown | |
| Building controls | Orange | |
| P.A. Fire Safety | Pink | |
| Fire alarm | Red | |

2.5 TRADE QUALIFICATIONS

- .1 The work shall be carried out by licensed electricians with minimum five years experience who hold Ontario Certificates of Qualifications, and current Contractor's license.
- .2 Installation methods and materials to be of strictest quality, and conform to Canadian General Standards Board, Canadian Standards Association, Ontario Building Code and all Local and Provincial Codes and Standards. Discrepancy in Codes to mean strictest rule applies.
- .3 The ratio of Journeymen to Apprentices shall not exceed the ratio in the Trade Qualifications and Apprenticeship Act of Ontario.
-

2.6 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment “equipment green” finish to EEMAC Y1-1.
 - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

2.7 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

2.8 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible after equipment is installed.

2.9 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and Departmental Representative.
- .2 Porcelain enamel signs, minimum size 175 x 250 mm.

Part 3 Execution

3.1 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200 mm.
- .4 Panelboards, disconnects, splitters: as required by Code or as indicated.

3.2 CONDUIT AND CABLE INSTALLATION

- .1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
 - .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
-

- .3 Provide all required accessories, inserts, hangers, toggle bolts, support channels, anchors etc. as required to complete systems.

3.3 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to values and settings, as per approved coordination study.

3.4 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads operating. Do tests after space is fully occupied and operational. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment, after space is fully occupied and operational.
 - .3 Submit, at completion of work, report listing phase and neutral currents on panel boards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.
 - .2 Protective Device Coordination Study
 - .1 Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at the location.
 - .2 A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation. System coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of eight years of current experience in the coordination of electrical power systems.
 - .3 The following information shall be provided on all curve sheets.
 - .1 Device identification and associated settings/size.
 - .2 Voltage at which curves are plotted.
 - .3 Current multiplier.
 - .4 ANSI frequent fault damage curve.
 - .5 Cable insulation damage curves.
-

- .6 Transformer inrush point.
- .7 Single-line for the portion of the system.
- .8 Motor starting profiles (where applicable).
- .3 Conduct and pay for following tests:
 - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .5 Insulation resistance testing.
 - .1 Check resistance to ground before energizing.
 - .2 Carry out tests in presence of Departmental Representative.
 - .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
 - .4 Submit test results for Departmental Representative's review.
 - .5 Hot spot testing:
 - .1 After 24 hours of operation under full load, perform infrared tests on all cable terminations and connections and all transformer, panel and breaker connections, to ensure the integrity of the system.
 - .2 Tests to be carried out by using an infrared camera.
 - .3 Terminations and/or connections failing tests shall be replaced immediately as part of the contract.
- .6 Perform tests prior to energizing electrical or mechanical systems.

3.5 FIRE AND SMOKE STOPPING

- .1 Provide fire and smoke stopping where conduits, cables, trays, etc., penetrate floor slabs or fire rated walls with an approved ULC listed putty, equal to 3M caulk CP25 and putty 303.
- .2 In accordance with Section 07 84 00 – Fire Stopping.

3.6 SPRINKLER-PROOF EQUIPMENT

- .1 Provide sprinkler-proof equipment in all areas to the local authorities' requirements.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.
- .2 Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.1HB-12, CE Code Handbook, an Explanation of Rules of the Canadian Electrical Code, Part 1.
 - .3 CSA C22.2 No. 18.2-06, Nonmetallic Outlet Boxes.
 - .4 CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Fittings, and Associated Hardware.
 - .5 CSA C22.2 No. 40-M1989 (R2009), Cutout, Junction and Pull Boxes.
 - .6 CSA C22.2 No. 41-07, Grounding and Bonding Equipment (Bi-National Standard, with UL 467).
 - .7 CSA C22.2 No. 56-04 (R2009), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .8 CSA C22.2 No. 65-03 (R2008), Wire Connectors (Tri-National Standard, with UL 486A-486B and NMX-J-543-ANCE-03).
 - .9 CSA C22.2 No. 83-M1985 (R2008), Electrical Metallic Tubing.
 - .10 CSA C22.2 No. 83.1-07, Electrical Metallic Tubing – Steel (Tri-National Standard, with UL 797 and NMX-J-536-ANCE-2007).
 - .11 CSA C22.2 No. 0.4-04 (R2009), Bonding of Electrical Equipment.
- .2 Underwriters Laboratories (UL):
 - .1 UL 1 11th Edition (2005), Standard for Flexible Metal Conduit.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings and product data in accordance with Section 01 00 10 – General Instructions.

1.4 OVERCURRENT PROTECTION

- .1 Confirm overcurrent protection requirements of equipment supplied by Divisions 21, 23, 25 and 26 prior to installation.

1.5 LOCATION OF CONDUIT

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.
-

Part 2 Products

2.1 PANELBOARD

- .1 Existing 347/600V panelboard:
 - .1 Manufacturer: Schneider/Square D.
 - .2 Rating: 600/347 V, 3 phase, 3 wire, 400 A, short circuit current 18kA (rms symmetrical).
 - .3 Main Breaker Rating: 200A.

2.2 MOULDED CASE CIRCUIT BREAKERS

- .1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .2 Common-trip breakers: with single handle for multi-pole applications. Circuit breakers with interchangeable trips as indicated.
- .3 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 CABLES AND REELS

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicated cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.

2.4 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG (including ground wires).
- .2 Copper conductors: size as indicated:
 - .1 For applications up to 250 V: with thermoplastic insulation type RW90 rated at 600V.
 - .2 For applications up to 600 V: with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

2.5 CONDUITS

- .1 Rigid galvanized steel threaded conduit.
- .2 Electrical metallic tubing EMT, with steel set screw couplings and connectors.
- .3 Liquid-tight flexible metal conduit.

2.6 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
-

- .1 Two hole steel straps for conduits larger than 50 mm.
- .2 One piece universal strut clamps to secure conduit to struts.
- .3 Beam clamps to secure conduits to exposed steel work.
- .4 Channel type supports for two or more conduits at 1.5 m oc.
- .5 Six mm diameter threaded rods to support suspended channels.

2.7 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory “ells” where 90 degree bends are required for 25 mm and larger conduits.

2.8 FISH CORD

- .1 Polypropylene.

2.9 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1HB.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.10 JUNCTION AND PULL BOXES

- .1 Size boxes in accordance with CSA C22.1HB
- .2 Construction: welded steel enclosure.
- .3 Covers Flush Mounted: 25mm minimum extension all around.
- .4 Covers Surface Mounted: screw-on flat covers.

2.11 WIRE AND BOX CONNECTORS

- .1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required. Equal to T&B-PT Series.
- .2 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
- .3 Clamps or connectors for armoured cable as required.

2.12 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.7 mm thick, surface mounted or suspended.
 - .2 Equal to Unistrut, Burndy, Hilti or Cantruss.
-

Part 3 Execution

3.1 INSTALLATION

- .1 Confirm equipment locations and sizes as indicated on plans to ensure equipment will fit.
- .2 Secure floor and wall mounted equipment plum and square.
- .3 Connect supply and load feeders from all equipment.
- .4 Check factory made connections for secureness and electrical continuity.
- .5 Ensure adequate clearances around equipment for ventilation requirements and code.
- .6 Provide auxiliary equipment and connections as required.
- .7 Provide typed, dated panel directory for each affected panelboard on this project.

3.2 MOULDED CASE CIRCUIT BREAKERS

- .1 Provide schedule and coordinate the power shutdown of panels to Departmental Representative for breaker replacement.
- .2 Terminate wiring on load side and make connection to equipment.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following, transformers, starters, variable speed drives, disconnects, frames of motors, motor control centres, control panels, distribution panels and conduits etc.
 - .2 Make grounding connections in radial configuration only, with connections terminating at a single grounding point. Avoid loop connections.
 - .3 Bond single conductor, metallic armoured cables to cabinet at supply end with conductive plate, and provide non-metallic entry plate at load end.
 - .4 Provide continuous ground conductor for raceways, outlets, and junction boxes for all systems.
 - .5 Ground all transformer secondary neutrals and enclosures back to primary feeder distribution panel.
 - .6 Ground all transformer secondary neutrals and enclosures back to primary feeder distribution panel.
 - .7 Provide a ground conductor for all non-conductive raceways.
 - .8 Ground all systems raceways, provide ground bushings.
 - .9 Ground all gas piping within Building #6 AWG.
 - .10 Ground all ductwork separated by flexible connections.
 - .11 Provide #6 AWG copper ground conductor to all communications controls cabinets or backboards.
-

3.4 CONDUIT SYSTEMS

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Use electrical metallic tubing EMT except in where indicated or specified elsewhere.
- .3 Use liquid tight flexible metal conduit for connection to motors and for connection to equipment in damp, wet or corrosive locations.
- .4 Minimum conduit size: 21 mm.
- .5 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .6 Mechanically bend steel conduit over 21 mm dia.
- .7 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .8 Dry conduits out before installing wire.
- .9 Run parallel or perpendicular to building lines.
- .10 Run conduits in flanged portion of structural steel.
- .11 Group conduits wherever possible on channels.
- .12 Do not pass conduits through structural members.
- .13 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .14 Ream raceways to remove burrs.
- .15 Install fish cord in empty conduits.
- .16 Provide fish cord in all empty raceways.

3.5 WIRING

- .1 Install RW-90 conductors in raceways except as otherwise indicated.
- .2 Installation of type AC-90 will not be permitted, lighting fixtures shall be connected with EMT.
- .3 Leave minimum 200 mm length of conductor at junction and outlet boxes.
- .4 Splices shall not be pulled into conduits.
- .5 Provide approved wire pulling lubricants for cable installations in conduits.

3.6 OUTLET BOXES

- .1 Support boxes independently of connecting conduits.
 - .2 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
 - .3 Vacuum clean interior of outlet boxes before installation of wiring devices.
-

- .4 Provide circuit number identification on all junction boxes with electronically printed labels.
- .5 Identify systems for outlet boxes as required.

3.7 JUNCTION, PULL BOXES AND CABINETS

- .1 Install pull boxes in inconspicuous but accessible locations. Coordinate interferences with Mechanical Trades.
- .2 Mount cabinets with top not higher than 2m above finished floor except where indicated otherwise.
- .3 Install pull boxes as required by CSA C22.1.

3.8 WIRE AND BOX CONNECTIONS

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet tests in accordance with CAN/CSA C22.2 No. 65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.9 FASTENINGS AND SUPPORTS

- .1 Secure equipment to hollow masonry, tile and plaster surfaces with lead anchors or nylon shields.
 - .2 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
 - .3 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
 - .4 One piece universal strut clamps to secure conduit to struts.
 - .4 Suspended support systems
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
 - .5 For surface mounting of two or more conduits use channels at 1.5 m occasional spacing.
 - .6 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
 - .7 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
-

- .8 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .9 Do not use support or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .10 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

Part 1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 – Common Work Results for Mechanical.
- .2 Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for fire alarm systems.
 - .2 Trouble signal devices.
 - .3 Power supply facilities.
 - .4 Automatic alarm initiating devices.
 - .5 Supervisory Valves and Flow Switches monitoring Fire Pump

1.3 REFERENCES

- .1 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524-14, Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S537-13 – Standard for the Verification of Fire Alarm Systems.
- .2 National Fire Protection Agency
 - .1 NFPA 72- 2016, National Fire Alarm and Signaling Code.
 - .2 NFPA 20-2016 – Standard for the Installation of Stationary Pumps for Fire Protection

1.4 SHOP DRAWINGS

- .1 Submit shop drawings and product data in accordance with Section 26 05 00 – Common Work Results for Electrical.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Base Building Fire Alarm Contractor: Chubb Edwards.
 - .2 Provide services of representative or technician from manufacturer of system, experienced in installation and operation of type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing of system and to provide instruction to project personnel.

Part 2 PRODUCTS

2.1 SUSTAINABLE REQUIREMENTS

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
-

2.2 WIRING

- .1 Wire for low voltage DC circuits:
 - .1 No. 14 AWG minimum solid copper conductor
- .2 Insulation 90 degrees C minimum with nylon jacket.
- .3 Colour code wiring.

2.3 DUCT SMOKE DETECTORS

- .1 Provide detectors installed in ducts of photoelectric type and listed by ULC duct installation.
 - .2 Provide integral control and power modules required for operation with main control panel.
 - .3 Ensure detectors and associated modules are compatible with main control panel and suitable for use in supervised circuit.
 - .4 Detector circuits: 4-wire type where detector operating power is transmitted over conductors separate from initiating circuit. Malfunction of electrical circuits to detector or its control or power modules to cause operation of system trouble signals.
 - .5 Provide a separate, fused power circuit for each smoke detection initiating circuit.
 - .6 Failure of power circuit: indicated as a trouble condition on corresponding initiating circuit.
 - .7 Provide duct detectors in accordance with NFPA 90A.
 - .8 Provide duct detectors with approved duct housing, mounted exterior to duct, with perforated sampling tubes extending across width of duct.
 - .9 Activation of duct detectors to cause shutdown of associated air handling unit, annunciation at control panel and sounding of building evacuation alarms.
 - .10 Provide detectors with visible indicator lamp that flashes when detector is in normal standby mode and glows continuously when detector is activated.
 - .11 Provide remote indicator lamp for each detector.
 - .12 Permanently label remote indicator with description and name of associated air handling unit(s).
 - .13 Provide each detector with remote test switch. Mount switch not more than [1.8] m above finished floor.
 - .14 Permanently label test switch with description and name of associated air handling unit(s).
 - .15 Acceptable Manufacturer: Chubb Edwards
 - .1 Specifications
 - .1 4F to 158F operating range with 100 ft/min to 4,000 ft/min air velocity
 - .2 Operating humidity: 10 - 93% relative humidity non-condensing
 - .3 0.67 to 2.46% obscuration/ft
 - .4 24V DC, 24V AC, 120V AC
-

- .5 Standby current: 77.9 mA @ 24V DC
- .6 Alarm current: 124.3 mA @ 24V DC

Part 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524.
- .2 All new locations for devices shall be coordinated by contractor between mechanical trades to ensure that they are installed in a location which will permit access to the devices for inspection and testing.
- .3 Provide new duct smoke detectors in ductwork indicated.
 - .1 Provide connection to fire alarm panel with addressable module.
 - .2 Provide connection between duct smoke detector and fire alarm shut down contact on VFD of AHUs.
- .4 Connect signaling circuits to main fire alarm control panel.
- .5 Install end-of-line devices.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests:
 - .1 Perform tests in accordance with CAN/ULC-S537.
 - .2 Fire alarm system:
 - .1 Simulate grounds and breaks on alarm and signaling circuits to ensure proper operation of system.
 - .2 Class B circuits.
 - .1 Test each conductor on circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Test each conductor on circuits for capability of providing alarm signal during ground-fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Manufacturer's Field Services:
-

- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 TRAINING

- .1 Arrange and pay for on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

3.5 CLEANING

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.