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**SPECIFICATIONS:**

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**DRAWINGS:**

<u>DISCIPLINE</u>	<u>NUMBER</u>	<u>TITLE</u>
	G1	Drawing List & Site Key Plan
MECHANICAL	M1	Mechanical General Notes, Legends, Schedules & Details
	M2	Roof Level HVAC Demolition
	M3	Roof Level HVAC New Work
	M4	Basement & Third Level HVAC Demolition & New Work
ELECTRICAL	E1	Electrical General Notes, Legends, and Schedules
	E2	Electrical Single Line Diagram and Basement Keyplan
	E3	Partial 3 <sup>rd</sup> LVL Power & Systems Demolition & New work
	E4	Partial 4 <sup>th</sup> LVL Power & Systems Demolition & New work

**Part 1            General**

**1.1                INTENT**

- .1    Intent of this Tender call is to obtain a firm price offer to replace rooftop units RTU-1, RTU-2 & RTU-3. RTU-1 shall be supplied and installed by contractor and RTU-2 and RTU-3 supplied by Departmental Representative and installed by Contractor. Provide various upgrades and refit the Heating Ventilating Air Conditioning System serving office area 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 removal RTU-1, RTU-2 & RTU-3.
- .3    Provide adaptor curbs for new rooftop units, curbs to transition from existing roof curbs to new RTUs.
- .4    Relocation of bypass dampers & associated controls.
- .5    Erection & installation of new mechanical and electrical infrastructure, RTU-1 and pre-purchased equipment (RTU-2 and RTU-3) as detailed on drawings and specifications.
- .6    Electrical provisions for future humidifiers serving RTU-3.
- .7    Perform work in accordance with Construction Schedule as outlined in this Section.
- .8    Work shall be phased in accordance with construction drawings & documents as to permit the operation of existing equipment serving existing office spaces with minimal shutdowns.

**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.
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**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, fire fighting and life safety in building in use.

**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.
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**1.11 TEMPORARY UTILITIES**

- .1 Power will be supplied by the Departmental Representative at no cost to the contractor. Power to be provided within CSA discretion. The contractor shall coordinate the use of existing services with Departmental Representative.

**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 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.
  - .5 Protect operatives and other users of site from all hazards.
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**1.15 HOARDING**

- .1 Erect temporary site enclosure around work site in mechanical room & around perimeter of waste disposal bin. Temporary site enclosures shall be reviewed with and approved by Department Representative.
- .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**

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- .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 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 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 Removal and installation of new RTUs
    - .3 For building service interruptions, provide at least seventy-two (72) hours notice.
  - .8 All building operations in areas not under construction must be maintained during all phases of construction.
  - .9 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.
  - .10 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.
    - .5 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must
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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.

- .11 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.
  - .12 Project milestones form interim targets for Project Schedule:
    - .1 On site mobilization starting on Construction Start date.
    - .2 Phase I:
      - .1 Isolation, disconnection & removal of existing RTU-2 c/w associated ductwork, natural gas piping, electrical service & controls.
      - .2 Modification of roof curb to allow for installation of new RTU-2.
      - .3 Craning and erection of RTU-2 (supplied by Departmental Representative) c/w associated ductwork, natural gas piping, electrical service & controls.
      - .4 Removal & relocation of existing bypass damper & actuator c/w associated ductwork.
      - .5 Completion of mechanical, electrical, controls, testing, commissioning and certification of RTU-2 performance.
    - .3 Phase II:
      - .1 Isolation, disconnection & removal of existing RTU-3 c/w associated ductwork, natural gas piping, electrical service & controls.
      - .2 Modification of roof curb to allow for installation of new RTU-3.
      - .3 Craning and erection of RTU-3 (supplied by Departmental Representative) c/w associated ductwork, natural gas piping, electrical service & controls.
      - .4 Provision of electrical infrastructure for future humidifier for RTU-3.
      - .5 Removal & relocation of existing bypass damper & actuator c/w associated ductwork.
      - .6 Completion of mechanical, electrical, controls, testing, commissioning and certification of RTU-3 performance.
    - .4 Phase III:
      - .1 Isolation, disconnection & removal of existing RTU-1 c/w associated ductwork, natural gas piping, electrical service & controls.
      - .2 Installation of adaptor roof curb to allow for installation of new RTU-1.
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- .3 Craning and erection of RTU-1 (supplied by Contractor) c/w associated ductwork, natural gas piping, electrical service & controls.
  - .4 Completion of mechanical, electrical, controls, testing, commissioning and certification of RTU-1 performance.
  - .5 All work involved with shut-down, disconnection, removal, roof curb modification, erection & installation of new RTU-1, RTU-2 & RTU-3 shall be completed during silent hours on weekends to ensure RTU-1, RTU-2 & RTU-3 are operational during regular hours.
  - .6 Testing and commissioning.
  - .7 Construction Completion and turnover to Departmental Representative including cleanup prior to Construction Completion date.
- .13 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 I:
      - .1 Electrical disconnection.
      - .2 Supplied equipment long delivery items.
      - .3 Removal of existing RTU-2.
      - .4 Craning of new RTU-2 onto roof.
      - .5 Construction of new RTU-2.
      - .6 Electrical new work.
      - .7 Mechanical new work.
      - .8 Controls.
    - .6 Phase II:
      - .1 Electrical disconnection.
      - .2 Supplied equipment long delivery items.
      - .3 Removal of existing RTU-3.
      - .4 Craning of new RTU-3 onto roof.
      - .5 Construction of new RTU-3.
      - .6 Electrical new work.
      - .7 Mechanical new work.
      - .8 Controls.
    - .7 Phase III:
      - .1 Electrical disconnection.
      - .2 Supplied equipment long delivery items.
      - .3 Removal of existing RTU-1.
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- .4 Craning of new RTU-1 onto roof.
- .5 Construction of new RTU-1.
- .6 Electrical new work.
- .7 Mechanical new work.
- .8 Controls.
- .8 Testing, commissioning and certification.
- .9 Correction of deficiencies.
- .10 Cleanup.
- .11 Testing, and commissioning by Departmental Representative.
- .12 Turnover of site to Departmental Representative.
- .13 Operational & maintenance manual submittals, etc.
- .14 Demonstration and training for Departmental Representative's personnel.
- .3 Allow in schedule for review of shop drawing submissions by departmental representative.
- .14 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.
- .15 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
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- 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, 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 Flexible ductwork and piping connections,
    - .4 Ductwork Dampers,
    - .5 Piping materials,
    - .6 Any mechanical piping joint systems,
    - .7 Seismic Support Details,
    - .8 Thermal Insulation and Jacketing,
    - .9 Support details,
    - .10 System Identification,
    - .11 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
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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.

- .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.
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- .8 Operating weight.
  - .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.
  - .3 RTU-2 and RTU-3 are currently on site. Contractor shall allow to move the new RTU’s from their current storage location, transport to the construction site and hoist in place.
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**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.
- .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 balancing has been completed, as applicable.
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- .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.
  - .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 spare parts and replacement parts have been provided and receipt of same acknowledged.
  - .9 The cleaning up is finished in all respects.
  - .10 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.
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**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.

**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.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used

**1.1 GENERAL**

- .1 All procedures and notes shown on this section are to replace “DFL projects general notes & procedures” shown on drawings M1 & E1.
- .2 “Mechanical general notes” on drawing M1 are to remain as is.
- .3 “General electrical notes” on drawing E1 are to remain as is.

**1.2 DFL PROJECTS GENERAL NOTES, & PROCEDURES**

- .1 All project’s architectural, structural, civil, mechanical and electrical drawings must be read in conjunction with each other and with all issued contract documents and specifications, except where replaced or changed by directive or corrective addenda or revised drawings and specifications.
  - .2 General contractor to carefully examine & review all construction documents (drawings, specifications & addenda), if any discrepancy occurs between drawings or between drawings & specifications or between English & French drawings & specifications translations, the contractor shall - during tendering - assume the larger / greater / most complete scope with no additional cost to CSA. Any discrepancy shall be referred to the engineer before proceeding with any work.
  - .3 The general contractor shall arrange and pay for all necessary permits, inspections & re-inspections required to be performed by local authorities having jurisdiction including inspection and testing except for building permit to the City of Ottawa which will be applied for by CSA. Turn over to the owner all original approval documentation & certificates.
  - .4 Contractor to be responsible for the provision (supply and installation) of all materials, equipment & services shown on the project drawings & specifications as required for a fully operable system, unless changed or replaced by revised drawings, specifications or addenda.
  - .5 The general contractor shall be responsible for all architectural, structural, mechanical, electrical, plumbing & fire protection work. Be responsible for all floor cutting, core drilling, all chases, openings and patching as may be required by all sub trades who may or may not be under his contract agreements.
  - .6 External contractors may be hired directly by CSA to perform specialty work as part of the overall project scope and within project construction boundaries. Such external work scope, duration & sequence of activities will be identified clearly in project document and will not form as part of general contractor scope or contract. General contractor -being responsible for the entire project & boundaries- must coordinate and supervise external contractors work, standards and code compliance. GC to review and approve external contractor site specific project health & safety plan (PHSP) before starting any work and assure that their PHSP plan is followed & fully implemented for the entire duration of their work.
  - .7 Drawings are not intended to show the details & route of each component to be installed or removed. They are only providing a general overview of the project scope. The
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contractor shall be responsible to review the site conditions during the tender period and examine the extent of all demolition, removals, modifications & new installations work to include in the tender price all necessary labor and material required for a fully operable system as intended.

- .8 Immediately after awarding the contract, contractor to check the availability & delivery times of all supplied architectural, structural, mechanical & electrical items. Provide CSA project manager with project schedule, critical path of tasks, complete shop drawings, interference drawings, product & MSDS data on manufactured items, samples, mock-ups and all other information to confirm the contractor's understanding of the design intent documents prior to undertaking those portions of the work. Provide an updated weekly schedule by end of each week in "MS Excel" or "MS Project" electronic format.
  - .9 All materials and workmanship shall be in accordance with the current codes, by-laws and ordinances of the relevant building authorities where varied by the project spec.
  - .10 All dimensions to be verified on site. Exact location & elevation of equipment is subject to site measurements.
  - .11 Contractor to submit shop drawings for all material, equipment & fixtures to engineer for approval before commencing installation or ordering. All samples to be provided upon CSA request at no additional cost.
  - .12 All supplied materials, fixtures & equipment to be new, free from defects, certified & approved by code. Reuse of any existing parts in not permitted unless approved by CSA.
  - .13 CSA shall be given the option of retaining any removed or demolished components or equipment. Coordinate and hand over to CSA project manager as required. Dispose of any remaining or unwanted equipment or services and remove off site in a legal manner and comply with the environmental protection act, Ontario regulations for waste management program. Certificate of disposal to be handed over to owner after removals are done.
  - .14 Install all equipment in full accordance with the manufacturer specifications & recommendations.
  - .15 All trades should be licensed to perform all work shown on the drawings including removals & demolition in the province of Ontario.
  - .16 Do not damage existing fire separations and fire protections in the project areas. Any damages incurred to existing fire separations and protections shall be restored to approved conditions to meet required rating and codes at no additional costs to CSA.
  - .17 Under any circumstances, do not block required access to exits and fire escape routes during the project duration. All existing life safety systems and indicators shall be operational at all times.
  - .18 Smoke eaters & powered exhaust fans vented to outside of building must be used during all brazing / welding / soldering / cutting / grinding activities to minimize contamination
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& odor to adjacent areas particularly in clean rooms. Provide three full working days' notice to CSA to arrange and issue hot work permits. Contractor to provide their own fire extinguisher, use of DFL fire extinguishers is not permitted. All hot work to be done by 2:30pm max allowing for one hour fire watch, all hot work areas to be inspected by GC site representative at the end of the fire watch period.

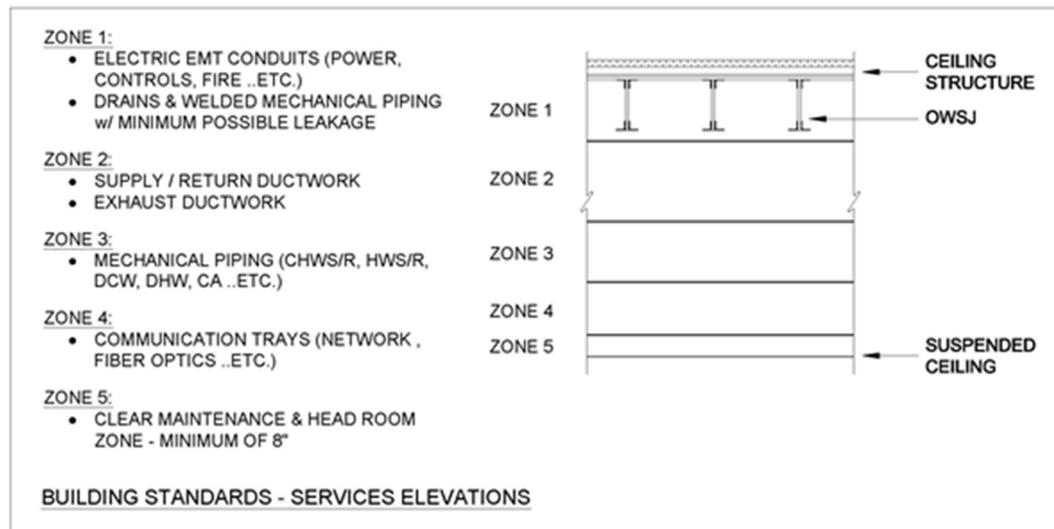
- .19 Contractor to properly protect all interior elements (all architectural finishes, flooring, ceilings, siding, walls, windows, doors, furniture, lab equipment, cranes, electrical systems, HVAC systems, communication & security systems ... etc.) during all construction activities & tasks (demolition, modifications & new), 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. All existing & new finishes within construction area should be equal or better condition than it was before starting construction, all at no additional cost to CSA.
  - .20 Contractor to protect building HVAC system during construction from dust, smoke and any other form of contaminations. Apply new clean filter sheets on all supply air openings and diffusers. Block all return air openings & grilles with new clean plastic sheets. Carefully remove all protective filters & plastic sheets after completion of all project activities and cleaning. Use of duct tape, packaging tape, gorilla tape & tuck tape for protective materials installation is not permitted as it will damage the finishes, use of nylon cable ties (tie wraps) or painter tape is preferred.
  - .21 Contractor is responsible to properly protect all exterior building and campus elements (landscape, pavers, sidewalks, campus roads, lawn, trees, plants, courtyards, signs, camera & light posts, building envelope & siding, windows, doors, roofing, gas lines, HVAC equipment ... etc.) from any damages resulting for any interior or exterior work (demolition, modifications & new). Upon noticing of any damages, CSA will engage external consultant / specialist (at GC cost) to assess damages, specify the repair standards, method & procedure if required and inspect the remedial work quality done by GC for approval, all at no additional cost to CSA.
  - .22 Exact tarping limits and access routes to be determined on site in coordination with CSA project manager.
    - .1 All tarps to be new heavy duty polyethylene, water / mildew / tear resistant, white, tight sealed from deck to floor and from wall to wall, contractor to provide access zippers or doors as required by CSA, use metal studs as framing supports, no wood materials to be used in tarps construction unless approved by CSA. Use insulated new tarps for exterior protection.
    - .2 Approved methods to attach studs / tarps to building as follow:
      - .1 On floors: heavy duty commercial double sided tape to secure metal studs to floors, use of screws or tapcons are not permitted.
      - .2 On drywalls / masonry / metal siding walls: duct or tuck tape is not allowed directly on building finishes as it will damage finishes when removed; apply masking paint green tape first and then duct / tuck tape on top of it. Studs can be screwed to drywall / masonry walls giving that all holes will be patched & painted (whole wall / area to be painted, small / local paint patches are not permitted).
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- .3 Tarps could be hanged off building steel structural using high strength cable ties, provide heavy gauge unistruts as needed for cross runs or to distribute tarps load.
  - .4 Hanging tarps from building services (ductwork, conduits, pipes, supports, hangers ... etc.) is not permitted.
  - .5 Contractor is responsible for cleaning, patching, repairing & painting all damaged surfaces & tape marks after removing tarps. Walls and ceilings to be painted in full, no local paint patches are permitted.
  
  - .23 Provide floor protection to entire project areas before any work starts as follow:
    - .1 Floor to be wiped clean from any debris or dust particles.
    - .2 Provide min. 1/8" foam layer directly on all flooring.
    - .3 Provide hardwood / MDF sheets on top of foam layer, all sheet's joints to be duct-taped to prevent debris / dust from getting trapped under the protection sheets. Use of OSB sheets is not permitted in clean rooms.
  
  - .24 Provide furniture and equipment protection as follow:
    - .1 Office / lab furniture and equipment: to be completely covered and wrapped with new heavy duty clear plastic roll sheets.
    - .2 Sensitive lab testing equipment: to be completely covered and wrapped with new heavy duty clear plastic roll sheets, clean scaffolding to be erected on top of all lab equipment to protect from possible falling objects.
  
  - .25 Contractor to provide bilingual construction access & safety signage, signs to be posted on all project fences, boundaries & entrances at the start of project and before commencing any work.
  
  - .26 Access to the site for material, work forces and for waste removal is to be coordinated with CSA project manager, use only elevators designated by CSA and protect them from damage.
  
  - .27 When testing activities are not underway, large or small loading docks can be used to move materials in and out of the building from 7:00 am to 8:00 am without CSA needing to provide notice to building staff. If access is required after this time or for longer periods, three full working days' notice must be provided to CSA project manager to confirm availability and arrange for proper notices.
  
  - .28 Contractor to provide, clean & maintain his own portable sanitary facilities, building washrooms shall not be used for construction unless approved by CSA project manager.
  
  - .29 Only designated areas are to be used for lunch and break time. All other areas are off limits.
  
  - .30 Contractor to respect all building floor loading limitations, coordinate and confirm with CSA project manager prior to bring in any heavy tools, equipment and lifts.
  
  - .31 Only the use of clean electrical lifts is permitted anywhere inside the building, use of propane / diesel / gas powered lifts are not permitted except when used outside the building. All exhausts to be aimed opposite to and away -as much as possible- from building envelope, windows, doors, entrances & HVAC intakes.
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- .32 General contractor shall be responsible to keep the owner's access areas and corridors clean at all times.
    - .1 Clean and remove all demolition and construction waste from project site on daily basis and upon completion of project.
    - .2 Transport all loose materials in / out of building in clean covered containers.
    - .3 Do not use CSA waste containers. An area will be designated for locating contractor waste bins upon request.
    - .4 Contractor to provide all cleaning equipment & supplies, use of building cleaning equipment or supplies are not permitted.
  
  - .33 Do not subject any part of the building to any noise, dust or any other unacceptable environmental conditions during the course of the project. Any noisy / dusty / smelly activities shall be done after regular working hours or weekends, coordinate with CSA project manager with a minimum notice of four full working days.
  
  - .34 All penetrations through walls and floors shall be saw-cut or core drilled. Jack hammering is not permitted. All walls, floors & ceilings penetrations to be sealed by contractor in accordance with applicable fire codes & the engineer's requirements. Use of powder actuated tools using explosives is prohibited.
  
  - .35 Parts noted to be supplied by CSA shall be fully installed & supported by contractor at no additional cost.
  
  - .36 Projects may take place in a cleanroom environment, mandating special measures be taken to reduce laboratory disruption. Class 8 (100,000) cleanroom standards are to be met for the area surrounding construction at all times and are subject to verification.
  
  - .37 All GC & sub-trades workers, inspectors, operators ... etc. have to be escorted at all times while in building and on campus.
    - .1 CSA will provide security commissionaires to escort personnel during normal working hours (Monday to Friday – 7:00am to 3:30pm), any escort request for additional work outside normal hours will be subject to management & availability approvals and will be back-charged to GC.
    - .2 Prior to project start, GC to provide a full list –as much as possible- of all personnel working on the project as well as engineers, suppliers, operators & inspectors to issue necessary forms for campus and CSA building access.
    - .3 Name, company name & nationality is required for each individual, non-Canadian will require a copy of passport, allow for two to three weeks for security check for non-Canadians.
    - .4 Visit Clearance Request (VCR) form will be issued by CSA security to campus security with all GC provided names prior to project start date, VCR form will be updated and resend to Campus security ONLY ONCE a week on Fridays' noon for next week access. Requests for additional names can be provided by GC from Monday morning until Thursday @ 1:00pm on every week for next week access, any names received after Thursday @ 1:00pm cannot be added for the next week and will be considered for the following week.
    - .5 Individuals who are not on VCR list will be denied access by campus security. No expiations and no emergency requests will be accepted.
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- .6 Provide at least four full working days' notice to CSA project manager for any after hours or weekend work requests for CSA management & campus approvals.
  - .7 Provide two full working days' notice for any delivery of materials or rental equipment delivery or pick-up (only name of the company and type of delivery is required – name of driver is not required) to issue the proper forms to campus security. General contractor must be on site to inspect & receive the shipment. If the delivery pertains to lifting equipment, one of the qualified contractors assigned to use the equipment must inspect and receive the lift from the rental company. No last minute request will be accepted.
  - .8 Notify CSA immediately of any change in schedule that affects the need for security escorts.
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- .38 General contractor representative has to be present on site at all times and accompany all sub-trade workers; trades & sub-trades are not allowed to be on site or to work without the presence of approved designated GC representative – no exceptions.
  - .39 All personnel (contractors, admin, inspectors, operators... except material drivers) must attend one-time mandatory DFL security briefing (20~30 minutes) before starting any work on site, adhere to the information presented at all times. Security briefing will take place on first day of the project and then on the following Mondays' morning only for added names upon GC request, no individual or emergency briefings requests will be allowed. Any person who did not attend this briefing will not be allowed to work on site – no exceptions.
  - .40 Improper / unclean / ripped clothing, foul language, improper behavior, smoking in undesignated areas including e-cigarettes will not be tolerated and worker will be escorted off campus immediately – no exceptions.
  - .41 CSA, at their discretion, may request a worker to leave the site if there is demonstrated impaired mental or physical capability affecting his/her work performance and possibly putting others at risk due to consumption of alcohol, cannabis or illegal substances.
  - .42 DFL is a high profile occupied building, use of music or radio on site is not permitted at all times.
  - .43 Any form of photos & video recordings (cameras, camcorder, cell phones, tablets, laptops .. etc.) are totally prohibited by any personnel at all times inside / outside DFL buildings or anywhere on campus – no exceptions. GC to submit request for project specific pictures to DFL project manager, photos will be taken by authorized DFL personnel only and sent to GC after security screening, allow for full two working days for screening and approval process. CSA reserves the right to screen & limit photos as permitted.
  - .44 CSA is committed to ensuring a healthy and safe environment for its employees, contractors and visitors and will align itself with contractors who share in this vision. The requirements outlined below are provided as reference and are there to assist the contracting company who performs the work and accepts this commitment completely:
    - .1 Ontario occupational health and safety act: <http://www.e-laws.gov.on.ca>
    - .2 Infrastructure health and safety association “guide to developing health and safety policies and programs in construction” a comprehensive guide geared to mid- to
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- large-sized general contractors for developing and implementing an effective health and safety program: <http://www.ihsa.ca>
- .3 Infrastructure health and safety association “construction health and safety manual”. guidance on hazard controls for Ontario contractors: <http://www.ihsa.ca>
  - .4 The general contractor will be required to prepare and submit to the CSA project manager a full site specific project health and safety plan, herein called PHSP, prior to the commencement of any works and within two weeks of contract award. Plan to be reviewed & approved by CSA before starting any work.
  - .5 The general contractor shall provide CSA project manager a copy of all notices or other written correspondence provided to or received by the Ontario Ministry of Labor for the duration of the contract.
  - .6 The general contractor shall fully implement the PHSP for the full duration of the contract.
  - .7 A copy of all applicable training certificates must be provided prior to commencing any work. Certificates must show exact company name and address that provided the training. CSA reserves the right to request the course outline from the company that provided the training. If the proof of training does not demonstrate the worker as being competent operators, further training may be requested by the CSA prior to commencing any work at no additional cost.
- .45 GC and all his sub-trades are responsible to provide all ladders, scaffolding, lifts, cranes and all other equipment & tools required for project scope including installing & removing tarps & protection materials. Use of building tools, equipment, trollies, forklifts, skids, ladders, lifts, cranes ... etc. are not permitted.
- .46 All trades to follow building service elevations standard as follow:



- .47 General contractor and all trades to strictly follow campus, DFL cleanrooms & CSA/DFL procedures at all times. GC is responsible to acknowledge & distribute all procedures to all his workers & sub-trades.

.48	Abbreviations:	
	CSA	Canadian Space Agency
	CSA*	Canadian Standards Association (for codes, certifications & standards)
	DFL	David Florida Laboratory (CSA testing & integration lab in Ottawa)
	S&F	CSA Security & Facilities
	B-Ops	DFL Building operations group
	EQF	DFL Environmental Qualification Facility (Thermal & structural testing group)
	RFQF	DFL Radio Frequency Qualification Facility
	TSS	DFL Technical Support Services (Shipping & receiving group)
	CRC	Communications Research Canada (Shirley's Bay campus custodian)
	GC	General Contractor
	OSB	Oriented Strand Board
	PHSP	Project Health and Safety plan (Site specific plan)
	MSDS	Material Safety Data Sheet
	TV#	Thermal Vacuum Chamber – Number #
	TCU	Thermal Conditioning Unit
	LN2	Liquid Nitrogen
	GN2	Gaseous Nitrogen
	CMP	Contamination Monitoring Plate
	CDACS	Combined Data Acquisition & Control System
	TRAPS	Thermal Response And Power System

### 1.3 GENERAL CAMPUS PROCEDURES

- .1 Access & Security:
    - .1 Contractors must sign-in to receive an access badge at the guardhouse (Campus entrance building 1). 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 four 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 the 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.
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- .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 have to 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 man-holes, 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 manner.
  - .5 Contractor to be responsible for any damages to campus roads, sidewalks, pavement, lawns, trees, plants, 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.
- .3 Communication & Photography:
- .1 Telephone at the Commissionaire's station or DFL basement is permitted for use.
  - .2 No cameras permitted on site; any requirement for pictures will come as a request to Project Manager.
- .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:
- .1 Cleanliness is of the utmost importance, it is expected that construction cleanup will be at the end of each day.
  - .2 Foul language or improper behavior will not be tolerated.
  - .3 Proper building and site protection must be provided at all times.
  - .4 Health and Safety practices must be strictly observed on site at all times.

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1        Section 01 00 10 – General Instructions
- .2        Section 23 74 00 – Packaged Outdoor HVAC Rooftop Units.

**1.2                ADMINISTRATIVE**

- .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 because of such default will be allowed.
- .2        Do not proceed with unit manufacture until submittal review is complete.
- .3        Present shop drawings and product data in SI Metric units.
- .4        Where items or information is not produced in SI Metric units converted values are acceptable.
- .5        Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents & stating reasons for deviations.
- .6        Manufacturer's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.
- .7        Manufacturer's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.

**1.3                SHOP DRAWINGS AND PRODUCT DATA**

- .1        The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Manufacturer to illustrate details & performance of equipment to Department Representative.
  - .2        Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for installation of units.
  - .3        Allow five (5) working days for Departmental Representative's review of each submission.
  - .4        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.
  - .5        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 & provide explanation for changes.
  - .6        Accompany submissions with transmittal letter, containing:
    - .1        Date.
    - .2        Project title and number.
    - .3        Manufacturer 's name and address.
-

- .4 Identification and quantity of each shop drawing, product data and sample.
  - .5 Other pertinent data.
  - .7 Submissions include:
    - .1 Date and revision dates.
    - .2 Project title and number.
    - .3 Name and address of:
      - .1 Supplier/Local Representative.
      - .2 Manufacturer.
    - .4 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 and BHP requirements.
      - .7 Standards.
      - .8 Operating weight.
      - .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 Finish.
      - .12 Gauge of materials.
      - .13 Vibration isolators stating locations and weight distribution.
      - .14 Controls (if required).
      - .15 Equipment operation and maintenance manuals.
      - .16 Equipment storage procedures and checklists.
  - .8 Submit single electronic format (pdf) of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
  - .9 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.
-

- .10 Submit single electronic format (pdf) copies of Manufacturer's Pre-Start-up & Start-up Inspection Reports, Commissioning and Testing Reports.
- .11 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .12 Delete information not applicable to project.
- .13 Supplement standard information to provide details applicable to project.
- .14 Following review and acceptance, copies will be returned, and fabrication 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 work may proceed.
- .15 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 Manufacturer submitting same, and such review shall not relieve Manufacturer of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of Contract Documents.

**1.4 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 Sealants.
  - .2 Lubricants.
- .2 MSDS to comply with Occupational Health and Safety requirements.

**1.5 OPERATION AND MAINTENANCE INSTRUCTIONS MANUALS**

- .1 Submit draft Operation and Maintenance Instruction Manual to Departmental Representative for approval, compiled in the following format:
    - .1 Electronic PDF format only. No hard copy for draft review.
    - .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.
      - .3 Name of project.
      - .4 Addresses, and telephone numbers of Supplier/Manufacturer with name of responsible parties.
      - .5 Schedule of products and systems, 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.
-

- .6 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.
    - .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 Manufacturer's and Departmental Representative's stamps. Indicate any changes made during fabrication.
    - .6 For each product or system:
      - .1 List names, addresses and telephone numbers of suppliers, including local source of supplies and replacement parts.
    - .7 Guarantees and Warranties in accordance with Section 01 78 00 – Closeout Submittals.
    - .8 Material Safety Data Sheets (MSDS).
    - .9 Manufacturers' Pre-Start-up, Start-up, Commissioning & Testing Field Reports.
    - .10 Manufacturers' Inspection Certificates.
    - .11 Training: refer to Section 01 00 10 – General Instructions.
    - .12 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. Hard copies shall be in a binder: 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.
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**Part 2          Products**

**2.1              NOT USED**

**Part 3          Execution**

**3.1              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
-

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.
-

- .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 list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
  - .13 Include test and reports as specified in Section 01 00 10 – General Instructions and Section 21 05 01 – Common Work Results for Mechanical.
  - .14 Additional requirements: as specified in individual specification Sections.
-

**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.
-

- .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 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 cm<sup>2</sup>.
    - .1 Fire-stopping to be applied in accordance with fire damper manufacturer's instruction.

**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 with the existing building automation system by Departmental Representative.
- .2    Pay for the testing and commissioning of RTU-1, RTU-2 & RTU-3.

**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    Install equipment and similar items parallel to or perpendicular to building lines.
- .4    Provide new materials and equipment of proven design, quality and of current models with published ratings for which replacement parts are readily available.
- .5    Uniformity:
  - .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.
- .6 RTU-1, RTU-2 & RTU-3 (New):
  - .1 Erect and install unit on an insulated seismic adaptor roof curb, level within 3mm and of sufficient strength to support the unit.
  - .2 Provide components furnished as per manufacturer's literature.
  - .3 Provide certified wiring schematics to the electrical division for the equipment and controls.
  - .4 Provide all necessary control wiring as recommended by the manufacturer. Provide condensate traps in accordance with manufacturers recommendations.
  - .5 Insulate all supply ductwork unless indicated otherwise.
  - .6 Provide ductwork connections to new unit. Provide new flexible ductwork at all connections to new unit.
  - .7 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.

## **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 RTU-2 & RTU-3 controls shall be provided by Divisions 21, 23, and 25 including power wiring to all control panels, interconnection between the RTUs 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.

#### **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 Show drawing for each input/output device, showing all information associated with each particular point including:
  - .1 Sensing element type and location
  - .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.
  - .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.

#### **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 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 On-site review of all system components with brief descriptions of functions and details.
  - .2 System Communications (overview).
  - .3 Operator interface functions for control of HVAC systems (detailed).
  - .4 Control descriptive logic (detailed for each system).
  - .5 Report generation (overview).
  - .6 Elementary preventative maintenance (detailed).
    - .1 General equipment layout.
    - .2 Sensors and controls maintenance and calibration.

**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 Duct equal or larger than:
      - .1 0.55m<sup>2</sup> cross sectional area of duct.
    - .2 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.

### 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.
  - .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 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.
  - .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 RTU-1, RTU-2 & RTU-3.
  - .2 Duct Systems.
  - .3 Controls.
  - .4 Fire Alarm Connections Interlocks.
- .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 Duct  
Insulation:

\_\_\_\_\_

- .5 Controls:

Modern Niagara

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 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for piping, valves and fittings for gas fired equipment.

**1.2 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.5, Pipe Flanges and Flanged Fittings.
  - .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.
- .2 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
  - .1 CAN/CSA B149, Natural Gas and Propane Installation Code Handbook.

**Part 2 Products**

**2.1 PIPE**

- .1 Steel pipe: to ASTM A 53/A 53M, Schedule 40, seamless as follows:
  - .1 NPS 1/2 to 2, screwed.
  - .2 NPS 2 1/2 and over, plain end, welded.

**2.2 JOINTING MATERIAL**

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: non-metallic flat.

**2.3 FITTINGS**

- .1 Steel pipe fittings, screwed, flanged or welded:
  - .1 Malleable iron: screwed, banded, Class 150.
  - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
  - .3 Welding: butt-welding fittings.
  - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A 47/A 47M.
  - .5 Bolts and nuts: to ASME B18.2.1.
  - .6 Nipples: schedule 40, to ASTM A 53/A 53M.

**2.4 VALVES**

- .1 Provincial Code approved, lubricated ball type.
-

**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 PIPING**

- .1 Install in accordance with Section 23 05 01 - Installation of Pipework, CAN/CSA B149.1.
- .2 Install drip points:
  - .1 At low points in piping system.
  - .2 At connections to equipment.

**3.3 VALVES**

- .1 Install valves with stems upright or horizontal unless otherwise approved by Departmental Representative.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

**3.4 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.

**3.5 ADJUSTING**

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1
- .2 Pre-Start-Up Inspections:
  - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
  - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

**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:
-

- 
- .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>
New ductwork below RTU	16
<u>All other areas</u>	<u>As per SMACNA</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:
-

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<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.

## 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/m<sup>2</sup>.
      - .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 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.

## **2.9 ACOUSTIC DUCT LINING**

- .1 Duct liner:
-

- .1 Flexible edge coated, mat faced, inorganic glass fibre bonded by a thermosetting resin, tightly bonded mat face.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with can/ulc-s102.
- .3 Use on flat surfaces where indicated.
- .4 25mm (1") thick, to cgsb 51-gp-11m, fibrous glass rigid board duct liner.
- .5 Density: 48 kg/m<sup>3</sup> (3 pcf) minimum.
- .6 Thermal resistance to be minimum 0.76 m.sq. X dc / w (4.4 ft.sq. X hr. X df/btu) for 25mm (1") thickness when tested in accordance with astm c177, at 24 c (75 f) mean temperature.
- .7 Duct sizes shall be free area sizes and not sheet metal sizes.

### 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
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 Main and sub-main ducts.
  - .2 For temperature readings:
    - .1 At outside air intakes.

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 01 00 10 – General Instructions
- .2 Section 01 33 00 – Submittal Procedures
- .3 Section 01 78 00 – Closeout Submittals

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)
  - .1 ANSI/ARI 210/240-03, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
  - .2 ARI 270-95, Sound Rating of Outdoor Unitary Equipment.
- .2 ANSI/UL 1995 B-1998, Standard for Heating and Cooling Equipment.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA B52-99, Mechanical Refrigeration Code.
  - .2 CSA C22.1 HB-02, Canadian Electrical Code Handbook.
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA)
  - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .6 American Society of Heating, Refrigeration & Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 90.1
  - .2 ASHRAE Standard 15

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 Submittal Procedures.
- .2 Closeout submittals in accordance with Section 01 78 00 Closeout Submittals.

**1.4 QUALITY ASSURANCE**

- .1 The following are to be used as selection criteria and are to be as specified: Air flow rates, external static pressures, humidity and temperature control requirements as specified herein.
  - .2 The following are to be equalled or bettered: Coil face velocities, filter face velocities, casing leakage rates, fan brake horsepower, unit inlet and outlet sound power levels, dimensions, unit weight.
  - .3 The following are to be met within 10% of specified values: Air pressure drops & airflows.
-

- .4 The Rooftop Units (RTU's) footprint is to be as shown in specifications, exact dimension and orientation of ductwork openings shall be identified in shop drawings.
- .5 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock.
- .6 RTU's and major components shall be products of the manufacturer regularly engaged in production of such equipment.
- .7 Fans shall conform to AMCA bulletins regarding testing and construction and bear the AMCA certified rating seal for airflow and sound.
- .8 Coils shall be AHRI certified.
- .9 Filter media shall be ULC listed.
- .10 Unit shall be factory CSA approved.
- .11 Unit shall be ASHRAE 90.1 & 15 compliant.
- .12 ETL Listed.

## 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 – General Instructions.
- .2 After construction, RTU's shall be cleaned thoroughly before shipping. All floor surfaces and wall surfaces shall be thoroughly degreased and cleaned. After cleaning, units shall be shrink wrapped using a heavy gauge heat shrinkable plastic wrap.
- .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .4 RTU-1 shall be offloaded by Contractor. Coordinate delivery and offloading with Department representative. Follow all Manufacturer's recommendations.
- .5 RTU-2, 3 are supplied by Department Representative and are currently onsite. Contractor shall allow to move from current storage onsite and lift into place at their cost. Coordinate moving and lifting with Department Representative.
- .6 Manufacturer shall allow to review off loaded units with Department Representative and fill out acceptance checklist to record and report any damages. Allow for patching and repair of weather protection covering to allow for inspection of units by Department Representative. Submit inspection report to Department Representative.

## 1.6 ROOFTOP UNIT PERFORMANCE CHARACTERISTICS

### 1. RTU-1 (Supplied and Installed by Contractor):

#### General:

Type:	Outdoor Packaged Rooftop Unit Carrier Model 48A
Application Type:	Variable Air Volume
Supply air:	3773 L/s
Return air:	3023 L/s
Outside air:	755 L/s
Mixed-Air Filter:	Field Installed 100mm filter rack,

	50mm MERV 8 & 50mm MERV 13 (filter supplied by Department representative)
ESP:	373 kPa
S/A fan:	VFD
S/A discharge:	downdraft
S/A fan motor power:	max 3.8 Kw
R/A inlet:	downdraft
O/A, E/A inlet/discharge:	Horizontal
EER (ASHRAE 360):	10.1
IEER:	12.3

*Dimensions:*

Unit Length:	4191 mm
Unit Width:	2388 mm
Unit Height:	1855 mm
Unit Shipping Weight:	2096 kg

*Cooling:*

Type:	DX Packaged
Ambient Air Temp:	35 Celsius
Entering Air Dry Bulb Temp:	30 Celsius
Entering Air Wet Bulb Temp:	19 Celsius
Leaving Air Dry Bulb Temp:	14 Celsius
Leaving Air Wet Bulb Temp:	13 Celsius
Gross Cooling Capacity:	74 Kwh
Sensible Cooling Capacity:	66 Kwh
Number of Compressors:	3
Part Load (%) Operation:	10, 30, 70, 100
Refrigerant Type:	R-410A

*Heating:*

Source:	Natural Gas
Natural Gas Input (max input):	102 Kwh
Natural Gas Output (max output):	59 Kwh
Efficiency:	81%
Stages:	5

*Electrical:*

Voltage:	575V
Phases:	3
Frequency:	60 Hz
Full Load Amps:	49 A
MCA:	52 A
MOP:	60 A

**2. RTU-2 (Supplied by Department Representative and installed by Contractor):***General:*

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Type:	Outdoor Packaged Rooftop Unit
Application Type:	Carrier Model 48A
Supply air:	Variable Air Volume
Return air:	2830 L/s
Outside air:	2264 L/s
Mixed-Air Filter:	566 L/s
	Field Installed 100mm filter rack, 50mm MERV 8 & 50mm MERV 13 filters (filter supplied by Department representative)
ESP:	373 kPa
S/A fan:	VFD
S/A discharge:	downdraft
S/A fan motor power:	max 3.8 Kw
R/A inlet:	downdraft
O/A, E/A inlet/discharge:	Horizontal
EER (ASHRAE 360):	10.1
IEER:	12.3
<i>Dimensions:</i>	
Unit Length:	4191 mm
Unit Width:	2388 mm
Unit Height:	1855 mm
Unit Shipping Weight:	2096 kg
<i>Cooling:</i>	
Type:	DX Packaged
Ambient Air Temp:	35 Celsius
Entering Air Dry Bulb Temp:	30 Celsius
Entering Air Wet Bulb Temp:	19 Celsius
Leaving Air Dry Bulb Temp:	13 Celsius
Leaving Air Wet Bulb Temp:	12 Celsius
Gross Cooling Capacity:	70 Kwh
Sensible Cooling Capacity:	56 Kwh
Number of Compressors:	3
Part Load (%) Operation:	10, 30, 70, 100
Refrigerant Type:	R-410A
<i>Heating:</i>	
Source:	Natural Gas
Natural Gas Input (max):	102 Kwh
Natural Gas Output (max):	82 Kwh
Efficiency:	81%
Stages:	5
<i>Electrical:</i>	
Voltage:	575V
Phases:	3

---

Frequency:	60 Hz
Full Load Amps:	49 A
MCA:	52 A
MOP:	60 A

**1. RTU-3 (Supplied by Department Representative and installed by Contractor):***General:*

Type:	Outdoor Packaged Rooftop Unit Carrier Model 48A
Application Type:	Variable Air Volume
Supply air:	3301 L/s
Return air:	2641 L/s
Outside air:	660 L/s
Mixed-Air Filter:	Field Installed 100mm filter rack, 50mm MERV 8 & 50mm MERV 13 filters (filter supplied by Department representative)
ESP:	435 kPa
S/A fan:	VFD
S/A discharge:	downdraft
S/A fan motor power:	max 5.6 Kw
R/A inlet:	downdraft
O/A, E/A inlet/discharge:	Horizontal
EER (ASHRAE 360):	10.1
IEER:	12.3

*Dimensions:*

Unit Length:	4191 mm
Unit Width:	2388 mm
Unit Height:	1855 mm
Unit Shipping Weight:	2096 kg

*Cooling:*

Type:	DX Packaged
Ambient Air Temp:	35 Celsius
Entering Air Dry Bulb Temp:	30 Celsius
Entering Air Wet Bulb Temp:	19 Celsius
Leaving Air Dry Bulb Temp:	13 Celsius
Leaving Air Wet Bulb Temp:	12 Celsius
Gross Cooling Capacity:	72 Kwh
Sensible Cooling Capacity:	61 Kwh
Number of Compressors:	3
Part Load (%) Operation:	10, 30, 70, 100
Refrigerant Type:	R-410A

*Heating:*

Source:	Natural Gas
Natural Gas Input (max):	102 Kwh

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Natural Gas Output (max):	82 Kwh
Efficiency:	81%
Stages:	5
Electrical:	
Voltage:	575V
Phases:	3
Frequency:	60 Hz
Full Load Amps:	49 A
MCA:	52 A
MOP:	60 A

**1.7 AIR HANDLING UNIT WARRANTY**

- .1 For the work of this Section 23 74 00, the 12-month standard warranty period shall be extended to include parts and labour for a period of 36 months from unit delivery.
- .2 Warranty on micro channel condenser coil shall be 3 years from delivery.
- .3 Stainless steel standard warranty of 5-years, non-pro-rated, shall be extended to a total of 10 years.
- .4 All warranty work shall be performed by Manufacturer or Manufacturer certified service technician only.

**Part 2 Products**

**2.1 GENERAL**

- .1 RTU-2 & 3 are supplied by Department Representative. RTU-1 supplied by Contractor shall be of same make and model as RTU-2 & 3.
  - .2 RTU's shall be complete with factory mounted return duct smoke detector compatible with the existing Chubb Edwards model EST, fire alarm panel.
  - .3 Factory-assembled, single-piece natural gas heating and electric cooling unit. Contained within the unit enclosure shall include but not limited too: all factory wiring, piping, tubing, refrigerant charge (R-410A), operating oil charge, refrigerant circuits, microprocessor-based control system and associated hardware.
  - .4 Roof mounted, self-contained VAV unit with gas burner and DX refrigeration and bear label of CSA, CGA, and ULC.
  - .5 Units to consist of cabinet and frame, supply fan, natural gas burner, air filters, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, return damper, & powered exhaust.
  - .6 Contractor shall provide insulated seismic adaptor curb for RTU-1,2,3. Site measure existing curbs prior to submitting shop drawing for approval.
  - .7 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW nominal.
-

## 2.2 CABINET

- .1 Constructed of galvanized steel, bonderized and pre-coated with a baked enamel finish.
  - .1 Top cover shall be 18-gage sheet metal with 12 mm thick, 680 g density, fiberglass insulation.
  - .2 Access panels and doors shall be 20-gage sheet metal with 12 mm thick, 680 g density, fiberglass insulation.
  - .3 All internal fiberglass shall be coated and provided with foil facing (not just the gas section).
  - .4 Corner and center posts shall be 16-gage galvanized steel.
  - .5 Base pans in the heating and return air sections shall be 16-gage galvanized steel.
  - .6 Base pans in the condenser section shall be 16-gage galvanized steel.
  - .7 Compressor rail shall be 12-gage galvanized steel.
  - .8 Condensate pan shall be stainless steel.
  - .9 Base rail shall be 16-gage galvanized steel.
  - .10 Fan deck shall be 16-gage galvanized steel.
- .2 Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM (American Society for Testing and Materials) B117 (scribed specimen).
- .3 Sides shall have person-sized insulated hinged access doors for easy access to the control box and other areas requiring servicing. Each door shall seal against a rubber gasket to help prevent air and water leakage and be equipped to permit ease and safety during servicing.
- .4 Interior cabinet surfaces shall be insulated with flexible fire-retardant material, coated on the air side, foil lined and meet the requirements of NFPA 90A.
- .5 Unit shall have a factory-installed sloped condensate drain connection made from an aluminized steel or optional stainless steel.
- .6 Equipped with lifting lugs to facilitate overhead rigging.
- .7 Filters shall be accessible through a hinged weather tight access panel without requiring any special tools.
- .8 All access doors shall be hinged with quarter turn handles.

## 2.3 FANS

- .1 Evaporator Fans:
    - .1 Double-width/double-inlet, centrifugal, belt driven, forward-curved type with single outlet discharge.
    - .2 Fan shaft bearings shall be of the pillow block type with positive locking collar and lubrication provisions.
    - .3 Statically and dynamically balanced.
    - .4 Evaporator fan shaft bearings shall have a life of L50 at 200,000 hours at design operating conditions in accordance with ANSI B3.15.
    - .5 Solid fan shaft construction.
-

- .6 Provide adjustable variable pitch motor pulleys.
- .2 Condenser Fans:
  - .1 Fans shall be direct-driven propeller type only, with corrosion-resistant blades riveted to corrosion resistant steel supports.
  - .2 Discharge air vertically upward and protected by PVC coated steel wire safety guards.
  - .3 Statically and dynamically balanced.
- .3 Supply Fan Drive:

Unit shall be provided with variable frequency drive (VFD) factory mounted and wired. The VFD shall control motor speed to maintain duct static pressure set point. VFD drive shall be integrated and programmed to work with on board RTU controller.

## 2.4 COMPRESSORS

- .1 Fully hermetic, scroll type compressors with overload protection and short cycle protection with minimum on and off timers.
- .2 Factory rubber-in-shear mounted for vibration isolation.
- .3 Reverse rotation protection capability.
- .4 Crankcase heaters shall only be activated during compressor off mode.
- .5 Units shall be capable of cooling reduction by hot gas bypass control.

## 2.5 COILS

- .1 Standard evaporator coil shall have aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
- .2 Standard condenser coil shall be microchannel design. The coil shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Microchannel coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for the fins, tubes and manifolds.
- .3 Coils shall be leak tested at 1034 KPa and pressure tested at 4481 KPa.

## 2.6 GAS HEATING SECTION

- .1 Induced-draft combustion type with energy saving direct spark ignition systems and redundant main gas valves.
  - .2 The heat exchanger shall be of the tubular section type constructed of a minimum of 20-gage type 409 stainless steel.
  - .3 Burners shall be of the in-shot type.
  - .4 All gas piping shall enter the unit cabinet at a single location, on side of unit.
  - .5 Induced Draft Fans:
    - .1 Direct-driven, single inlet, forward-curved centrifugal type.
    - .2 Statically and dynamically balanced.
-

- .3 Made from steel with a corrosion-resistant finish.
- .4 Permanently lubricated bearings.
- .5 Thermal overloads.
- .6 Automatic safety reset.
- .6 High-corrosion areas such as flue gas collection and exhaust areas shall be lined with corrosion resistant material.
- .7 Type 409 stainless steel shall be used in heat exchanger tubes and in vestibule plate.
- .8 Gas burner control shall be controlled with a microprocessor-based controller with integral fault detection and logging with LED fault notification.
- .9 Anti-cycle protection.
- .10 Vertical flue gas deflector.

## **2.7 REFRIGERANT COMPONENTS**

- .1 Unit shall be equipped with dual refrigerant circuits each containing:
  - .1 Solid core filter drier.
  - .2 Thermostatic expansion valve.
  - .3 Fusible plug.
  - .4 Service gauge connections on suction and discharge lines.
  - .5 Service valves.
  - .6 Hot gas bypass and controller.
- .2 Unit shall meet CSA B52.

## **2.8 FILTER SECTION**

- .1 Standard 50mm filter rack shall be removed and replaced with manufacturer supplied 100mm filter rack. Field modification of 50mm standard rack to 100mm filter rack shall be by this contractor and apply to RTU-1, 2,3. Manufacturer shall supply 100mm filter rack.
- .2 Filters shall be supplied by Department Representative.

## **2.9 CONTROLS**

- .1 Unit shall be provided with a factory mounted and wired standalone unit programmable controller.
  - .2 Provide outdoor air & return air enthalpy sensor for dual enthalpy economizer control.
  - .3 Compressor and gas burner shall have short cycle protection, pre-set for 5 minutes (adjustable).
  - .4 Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-volt transformer side. Transformers shall have a 75VA capacity.
  - .5 Utilize colour coded wiring with illustrated colour schematics.
-

- .6 Standalone controller shall be capable of the following control sequences:
  - .1 Smoke detectors shutdown.
  - .2 Phase monitor.
  - .3 Gas heating control.
  - .4 Economizer, dual enthalpy control.
  - .5 Supply air temperature control based on return air sensor and control of unit cooling and heating to maintain.
  - .6 Supply fan VFD control based on ductwork static pressure.
  - .7 Low and high-pressure switches
  - .8 Dirty filter status
  - .9 Modulating powered relief based on building static pressure
  - .10 Demand controlled ventilation based on return air CO2.
- .7 Both refrigeration system and gas heater shall be controlled by an integral microprocessor-based controller.
- .8 Integral microprocessor shall be able to communicate with the Carrier Generation 3 VVT control system called comfortview. Existing base building control system/operator workstation is a Carrier comfortview.

## 2.10 SAFETIES

- .1 Unit shall incorporate a solid-state compressor lockout which provides optional reset capability should any of the following safety devices trip and shut off compressor:
    - .1 Compressor lockout protection provided for either internal or external overload.
    - .2 Low-pressure protection (one low pressure switch per refrigeration circuit).
    - .3 Freeze protection (evaporator coil).
    - .4 High-pressure protection (one high pressure switch per refrigeration circuit).
    - .5 Compressor reverse rotation protection.
    - .6 Loss of charge protection.
    - .7 Welded contactor protection.
    - .8 Compressor high temperature.
    - .9 Motor thermal overloads (automatic reset).
  - .2 Supply-air sensor shall be located in the unit and should be used for economizer control and compressor stage control.
  - .3 Induced draft heating section shall be provided with the following minimum protections:
    - .1 High-temperature limit switch.
    - .2 Induced-draft motor speed sensor.
    - .3 Flame rollout switch.
    - .4 Flame proving controls.
    - .5 Redundant gas valve.
  - .4 Over amperage protection
-

**2.11 OPERATING CHARACTERISTICS**

- .1 Unit shall be capable of starting and running at 46 Celsius ambient outdoor temperature per maximum load criteria of AHRI Standard 340/360.
- .2 Unit with standard controls will operate in cooling down to an outdoor ambient temperature of 2 Celsius.
- .3 Unit shall be provided with fan time delay to prevent cold air delivery.

**2.12 ELECTRICAL REQUIREMENTS**

- .1 All unit power wiring shall enter unit cabinet at a single location, through the base.
- .2 Provide factory mounted non-fused disconnect. Disconnect shall be ETL listed.
- .3 Provide powered 120 Volt, 20A convenience outlet. Outlet shall be powered by separate line voltage connection, provided by others. Outlet shall be accessible from outside the unit.

**2.13 MOTORS**

- .1 Motors shall be designed for severe duty in accordance with IEEE 841 standards and shall meet NEMA MG1 Part 31.
  - .2 Motors shall be premium efficiency.
  - .3 Motors shall be operable at 575 Volts +10%/-15%, 0 to 320 Hz, 3-phase.
  - .4 Motor enclosure shall be totally enclosed fan cooled and rated to IP55. A non-metallic cooling fan shall be provided. Frame, end bells and fan cowl shall be manufactured of heavy duty cast iron. The end plates shall be sealed to the frame joints. Enclosure shall be epoxy coated and rated for ASTM B117-90 96-hour salt spray test.
  - .5 Motor windings shall have class F insulation with class B temperature rise ratings. Windings shall be 200C inverter spike resistant wire. Motor windings shall withstand 2000V transients. Motor service factor shall be 1.15 on sine wave power and 1.0 on VFD power.
  - .6 Bearings shall be re-greaseable without disassembly and provide for the elimination of purged grease. Bearing life shall be a minimum of L50 at 200,000 hours. Bearings shall be provided with seals.
  - .7 Motors shall be balanced to less than 0.08 inches per second (filter out) and the vibration test data shall be shipped with the motor.
  - .8 Nameplates shall be stainless steel and contain both NEMA data and bearing data.
  - .9 Motors shall be provided with a brush system to electrically ground the shaft and discharge any induced voltage on the motor shaft, with a direct path to ground.
  - .10 Drive service factor shall be selected with a 1.5 service factor.
  - .11 Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
-

- 
- .12 All condenser-fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, class F insulation and internal, automatic-reset thermal overload protection or manual reset calibrated circuit breakers.
  - .13 All indoor fan and power exhaust motors 3.7 Kw and larger shall meet the minimum efficiency requirements as established by the Energy Independence and Security Act (EISA) of 2007.

#### **2.14 VARIABLE FREQUENCY DRIVES (VFD)**

- .1 VFD shall packaged with unit, factory mounted and wired.

#### **2.15 ALUMINUM AIRFOIL DAMPERS**

- .1 Aluminum airfoil frames and blades shall be a minimum of 12-gauge extruded aluminum.
- .2 Frames shall be extruded aluminum channel with grooved inserts for vinyl seals.
- .3 Pivot rods shall be extruded aluminum interlocking into blade section. Bearings to be double sealed type with inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.
- .4 Bearing shall be designed so that there are no metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate bearing to eliminate friction in linkage.
- .5 Blade linkage hardware is to be installed in frame out of airstream. All hardware to be on non-corrosive reinforced material or cadmium plated steel.
- .6 Damper seals shall be designed for minimum air leakage by means of overlapping seals.
- .7 Outdoor and exhaust air dampers' internal hollows shall be insulated with 22 mm thick polyurethane foam with R factor of 5.0 per 25 mm. Blades shall be 100% thermally broken. Frame shall be insulated with polystyrene, R factor of 5.0 per 25 mm.
- .8 Damper blades shall be maximum 1,000 mm long per section.
- .9 Dampers greater than 2 sections wide shall be provided with a jackshaft.

#### **2.16 DAMPER OPERATORS**

- .1 Provide factory installed electronic damper operators with all linkage and hardware internally mounted.
- .2 Ensure operators are mounted in easily accessible sections of the RTU.
- .3 Damper actuators shall be spring return closed for OA and EA and open for MA.

#### **2.17 UNIT SOUND REQUIREMENTS**

- .1 Rooftop unit sound power levels are not to exceed the levels specified.
  - .2 Unit Acoustic Center Acoustics
-

	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Acoustic Center	66	80	87	90	91	86	83	78

**2.18 ELECTRICAL**

- .1 Unit approved by CSA.
- .2 Provide one (1) 575 V/60 Hz/3 phase, power connection c/w factory mounted non-fused disconnect.
- .3 Provide one (1) 120 V/60 Hz/1 phase, 20A, power connection for convenience outlets.
- .4 Wire from the motors to the motor control VFD shall be factory installed and wired.

**2.19 OPTIONS**

- .1 Ultra Low Leak Economizer:
  - .1 Differential enthalpy controlled integrated type consisting of dampers, actuator, and linkages in conjunction with control system to provide primary cooling using outdoor air, conditions permitting, supplemented with mechanical cooling when necessary.
  - .2 Dampers shall be a gear driven ultra low leakage type with blade and edge seals. Dampers shall exhibit a maximum leakage rate of 1.41 L/s per 0.09 square meter of area at 250 Pa pressure differential when tested in accordance with AMCA (Air Movement and Control Association) Standard 500.
- .2 Power Exhaust:
  - .1 Package shall include a modulating exhaust fan (relief fan) centrifugal style fan, direct-drive motor and damper for vertical flow units with economizer to control over pressurization of building. Control shall be based on building pressure.
- .3 Demand Controlled Ventilation:
  - .1 A CO2 sensor shall have the ability to monitor CO2 levels and relay information to the unit controller. The controller will use CO2 level information to modulate the economizer and provide demand-controlled ventilation. Sensor shall be factory installed and wired.
- .4 Return Air Smoke Detector:
  - .1 The smoke detector shall send input to the controller to shut down the unit in case smoke is detected. The smoke detector shall be factory installed in the return air section.
- .5 Condenser Coil:
  - .1 Provide condenser coil louvered hail guard, shipped loose for field installation. Field installation by others.
- .6 Roof Curb:
  - .1 New insulated and seismically rated roof curb adaptor shall be provided.

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- .2 Seismically designed & rated curb. Curb shall be reviewed and stamped by a Professional Engineer Licensed in the Province of Ontario. Submit stamped and signed shop drawings with RTU shop drawing for Department Representative approval.
  - .3 Curb shall be internally thermally insulated.
  - .4 Unit shall conform to NRCA standards.
  - .5 Curb height shall be 250 mm min.
  - .6 Curb shall be galvanized steel fully assembled and welded with wood nailer strip.
  - .7 Provide powered modulating relief air option.
  - .8 Provide exhaust air and outdoor air weather hoods, shipped loose for field installation.

**Part 3 EXECUTION**

- .1 Refer to section 01 00 10 – General Instructions for additional site scope of work (off-loading), testing, pre-start-up & start-up.
- .2 Contractor shall allow to install all field mounted options including but limited to powered exhaust, controls, weather hoods, etc.
- .3 Contractor shall provide new adaptor roof curbs specified for RTU-1,2,3.
- .4 Contractor shall retain the base building controls contractor for disconnect, reconnect and testing and verification on new RTU operation.
- .5 Contractor shall field modify filter racks from 50mm to 100mm with manufacturer supplied alternate rack. Install Department Representative supplied filters.

**Part 1            General**

**1.1                QUALITY CONTROL**

- .1    ISO 9000
- .2    CSA

**1.2                GENERAL REQUIREMENTS**

- .1    Use standard conduit box termination with slot screwdriver compression connector block unless otherwise specifically stated.
- .2    Operating conditions -0° to 32°C with 10 – 90% RH (non-condensing) unless otherwise specifically stated.

**Part 2            Products**

- 2.1                None.**

**Part 3            Executions**

**3.1                GENERAL**

- .1    All 120V (line voltage) controls by div-26. All 24vdc (low voltage) controls by div-25.
- .2    Provide EMT conduit c/w steel couplings and fittings for control wiring in exposed or exterior locations. Refer to electrical specifications for installation details.
- .3    Provide FT-6 plenum rated cable for control wiring in concealed areas.
- .4    Install equipment, piping, wiring, conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) Provide sufficient slack and flexible connections where necessary to allow for vibration of piping and equipment.
- .5    Install all equipment in readily accessible locations.
- .6    Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .7    Adhere to all manufacturers' wiring recommendations.
- .8    Materials shall be non-corrosive in the location installed.
- .9    All control wiring shall be tagged at each end.
- .10   Telephone or similar communication-type wire not acceptable for control wiring purposes.
- .11   Do not place control wiring in conduits containing 120 VAC or higher voltage power wiring.

**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.
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- .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 lamicaid 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	
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.
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**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.
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- .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 11<sup>th</sup> 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, short circuit current 18kA (rms symmetrical).
  - .3 Main Breaker Rating: 200A.
- .2 Existing 120/208V panelboard:
  - .1 Manufacturer: Schneider/Square D.
  - .2 Rating: 120/208 V, 3 phase, 4 wire short circuit current 10kA (rms symmetrical).

**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 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.

#### **3.3 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 1/10<sup>th</sup> 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.

### 3.4 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.

### 3.5 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.
-

**3.6 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.

**3.7 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.

**3.8 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.
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- .10 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.