Canadian Food Inspection Agency
Lethbridge Lab AHU Replacement
Project No: 115303307

SPECIFICATION MANUAL

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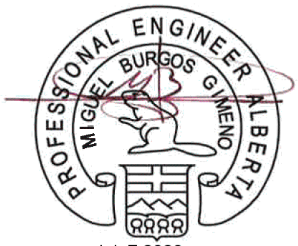

Jul. 7 2020

PERMIT TO PRACTICE
STANTEC CONSULTING LTD.

Signature

Date Jul. 7 2020

PERMIT NUMBER: P 0258

The Association of Professional Engineers,
Geologists and Geophysicists of Alberta

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1. GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 This project was approved by the need to replace the air handlers and associated equipment, with the added goals of increasing air handler redundancy, ventilation efficiency, and humidification consistency. To achieve these goals, the following activities will be performed:

.1 Addition of duct interconnections and control dampers that will allow air handler redundancy to lab spaces.

.2 Replacement of thirteen (13) air handlers and associated equipment and piping, including but not limited to isolation valves, control valves, heating and cooling coils, humidifiers, circulation pumps, and control dampers. Capacities to remain equal to existing except for SF-6, which will be increased in capacity to serve as backup to other air handlers.

.3 Replacement of three return fans.

.4 Demolition of glycol run-around system.

.5 Addition of a dedicated low-pressure steam boiler and reverse osmosis system to provide consistent source of steam to humidification coils.

.6 Relocation of air handling unit SF-1 and SF-2 outdoor air intake.

.7 Piping to be entirely flushed by the contractor after the renovation by Pace Chemicals Ltd.

.8 Addition of electrical, instrumentation, and control requirements associated with the above-mentioned activities with the intent of increasing efficiency of the ventilation system.

.9 Removal of asbestos containing materials and materials with lead based paint with leachable lead concentrations exceeding the hazardous waste criteria.

.2 During the construction project the building will be fully operational, which will require phasing the construction and doing certain operations that might interrupt service to the building during the weekends and/or at night. The contractor will have to coordinate the work with the users through the Departmental Representative.

.1 The Sewage Treatment room overheats. The replacement of SF-8, serving this room will be done during the shoulder season providing air exhaust and supply from the outside with temporary fans to be supplied by the contractor. Exhaust system will include HEPA filters before discharging the air outside. These temporary filters and the periodical replacement will be supplied by the contractor.

.2 Replacement of SF-9 and SF-10, serving the small and large animal incinerator rooms, will be done in sequence, so there is always one incinerator operational.

.3 The modifications to the chilled water pipes will be done during the winter, when the chilled water system is drained.

.4 Interconnections between SF-3 and SF-6 and SF-3 and SF-2 will be scheduled during a weekend and both will be done at the same time.

.5 Provide temporary cooling for room 149, where the freezers are located, when SF-1 is down without backup during the renovation.

.3 Individual laboratory shutdowns can be done during working hours, always they are limited to four hours. Longer shutdowns or those that will impact more than one laboratory at the same time will be scheduled on weekends, from Friday at 17:00 to Monday at 5:00 or at nights, from 17:00 to 5:00.

.4 Any shutdown must be scheduled with a minimum of one week of notice and approved by the Departmental Representative.

.5 Shutdowns may be cancelled without notice due to external factors beyond the Departmental Representative control, like food recalls, that require the use of the facility at 100% of its capacity or extended working hours.

1.2 CONTRACT METHOD

.1 Construct Work under single stipulated price contract.

1.3 WORK SEQUENCE

.1 Construct Work in stages to accommodate the continued use of premises by the users during construction.

.2 The design provides an indication of the constructions phasing. Contractor to verify the sequence of replacement of the units to keep the facility operational at all time, except brief programmed shutdowns, and modify the phasing as needed.

.3 Co-ordinate Progress Schedule and co-ordinate with Departmental Representative Occupancy during construction.

.4 Maintain fire access/control.

1.4 CONTRACTOR USE OF PREMISES

.1 Limit use of premises for Work, for storage, and for access, to allow:

.1 Building occupancy by users

.2 Work by other contractors.

.2 Co-ordinate use of premises under direction of Departmental Representative.

.3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

.4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.

.5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.

.6 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

1.5 OWNER OCCUPANCY

.1 Owner will occupy premises during entire construction period for execution of normal operations.

.2 Co-operate with Departmental Representative in scheduling operations to minimize conflict and to facilitate Owner usage.

1.6 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Execute work with least possible interference or disturbance to building operations, occupants, public and normal use of premises. Arrange with Departmental Representative to facilitate execution of work.

.2 Use only elevators existing in building for moving workers and material.

  .1 Protect walls of passenger elevators, to approval of Departmental Representative prior to use.

  .2 Accept liability for damage, safety of equipment and overloading of existing equipment.

1.7 EXISTING SERVICES

.1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission, with a minimum of two weeks of notice prior to shutdown.

.2 Where Work involves breaking into or connecting to existing services, give Departmental Representative and Facility Manager two (2) weeks of notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to operations.

.3 Provide alternative routes for personnel and vehicular traffic.

.4 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.

.5 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.

.6 Provide temporary services when directed by Departmental Representative to maintain critical building and tenant systems.

.7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.

.8 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

.9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.

.10 Record locations of maintained, re-routed and abandoned service lines.

.11 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.8 DOCUMENTS REQUIRED

.1 Maintain at job site, one copy each document as follows:

- .1 Contract Drawings.
- .2 Specifications.
- .3 Addenda.
- .4 Reviewed Shop Drawings.
- .5 List of Outstanding Shop Drawings.
- .6 Change Orders.
- .7 Other Modifications to Contract.
- .8 Field Test Report, System Components List c/w Commissioning Verification Forms and Check Sheets and Commissioning Issues/Resolution Log.
- .9 Copy of Approved Work Schedule.
- .10 Health and Safety Plan and Other Safety Related Documents.
- .11 Other documents as specified.

2. PRODUCTS

.1 Not used.

3. EXECUTION

.1 Not used.

END OF SECTION

Part 1 General

1.1 ACCESS AND EGRESS

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

1.2 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to 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.

.3 Where security is reduced by work provide temporary means to maintain security.

.4 Departmental Representative will assign space on site for use by Contractor's to install trailers to provide sanitary services, changing rooms and lunchrooms to construction personnel. Use of facilities by contractor is not allowed. Energy supply to trailers will be by the contractor. CFIA will provide a domestic water line. Contractor to prevent freezing of this line during cold weather.

.5 Use only elevators or existing in building for moving workers and material.

  .1 Protect walls of passenger elevators, to approval of Departmental Representative prior to use.

  .2 Accept liability for damage, safety of equipment and overloading of existing equipment.

.6 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Execute work with least possible interference or disturbance to building operations and occupants normal use of premises. Arrange with Departmental Representative to facilitate execution of work.

1.4 EXISTING SERVICES

.1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.

.2 Where Work involves breaking into or connecting to existing services, give Departmental two (2) weeks of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.

.3 Provide for personnel, pedestrian and vehicular traffic.

.4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 SPECIAL REQUIREMENTS

.1 Carry out noise generating Work Monday to Friday from 18:00 to 07:00 hours and on Saturdays, Sundays, and statutory holidays.

.2 Submit schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.

.3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.

.4 Keep within limits of work and avenues of ingress and egress.

.5 Ingress and egress of Contractor vehicles at site is limited to the back of the building.

.6 Deliver materials outside of peak traffic hours 17:00 to 07:00 and 13:00 to 15:00 unless otherwise approved by Departmental Representative.

1.6 SECURITY

.1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.

.2 Security clearances:

    .1 PSOS Reliability Level Security Clearance (completion of PSOS forms required of successful contractor and all sub-contractors) is required. Only Contractors and assigned employees pre-qualified to provide Contracting Services and invited to respond to this Request for Proposal (RFP) on the Project shall be allowed to submit a response.

    .2 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.

    .3 Obtain requisite clearance, as instructed, for each individual required to enter premises.

    .4 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

.3 Contractor personnel will be escorted at all times while in the laboratory.

1.7 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions. Smoking is not permitted.

END OF SECTION

Part 1 General

1.1 PURPOSE

.1 The purpose of this specification is to provide guidance to protect the health and safety of workers on site during the COVID-19 pandemic, providing clear expectations about the minimum measures to be taken by the contractor in reducing the risk of contracting or spreading COVID-19.

.2 Procedures and items listed here are the minimums that the contractor must follow on site.

.3 If during construction new preventive and/or protection measures are mandated by Alberta Health Services, the Government of Alberta, the Federal Government, the Town of Lethbridge, the Authority Having Jurisdiction, or any other competent authority, these will be implemented on site.

.4 Costs and time for the implementation of any of the measures indicated in this specification shall be included in the lump sum contract cost and the construction schedule.

.5 Follow the latest version of the following guidelines:

.1 Calgary Construction Association “Pandemic Planning for the Construction Industry – A Guide” document.

.2 Public Services and Procurement Canada “COVID-19: PSPC Standard Protocols for Real Property Construction Projects”

.3 Canadian Construction Association “COVID-19 - Standardized Protocols for All Canadian Construction Sites”

.6 These measures will be in place until the World Health Organization AND the corresponding authorities (Federal, Provincial and Local) declare the end of the COVID-19 pandemic and allow to release the protective measures and restrictions.

1.2 PERSONAL PROTECTION AND DISINFECTION

.1 The following materials will be available on site for use of workers and visitors to construction site:

.1 Face masks

.2 Nitrile Gloves

.3 Hand sanitizer

.4 Disinfectant wipes

.2 These items will be available at the construction sign-in point and within 3 meters (10 feet) of any active construction area.

.3 The contractor will have a person responsible to check and refill these materials every day, before the start of each work shift.

.4 Workers will replace face masks with clean ones at least every 4 hours.

.5 Use of face masks is mandatory when workers cannot maintain the physical distance (at least 2 metres / 6 feet distance) between individuals.

.6 Use of gloves is mandatory when the task requires people handling the same materials.

.7 The contractor will provide lined waste baskets for contaminated PPE at least at the following locations:

.1 Sign-in point

.2 Within 3 meters (10 feet) of any active construction area

.3 Construction washrooms

.4 Workers break rooms

.5 Construction offices

.8 Construction facilities will include at least two lavatories with hot and cold running water, soap, paper towels. If there are more than 100 workers on site, one additional lavatory will be provided per each 40 additional workers.

.9 Common areas like bathrooms, meeting rooms, lunchrooms and breakrooms will be cleaned and disinfected after peak times of use and at least: at the beginning of each shift, after lunch and at the end of the shift.

.10 Individual working spaces, like desks, will be cleaned and disinfected at least daily.

1.3 COMMON SPACES

.1 Common spaces capacity will be limited to 15 people and will be organized so the physical distance can be maintained.

1.4 MEETINGS

.1 Meetings will be online whenever it is possible.

.2 Presential meetings will be reduced as much as it is feasible to complete the work.

.3 Meetings are restricted to a maximum of 15 people and within spaces that allow to maintain the physical distance.

.4 When possible, maintain meetings outside.

1.5 SIGNAGE

.1 Information signage, escribing proper hand washing and hand sanitization techniques will be posted at hand washing and hand sanitization facilities.

.2 Information signage with items listed in point 1.2.1 of this specification will be posted at project entry points, break and lunchrooms, restroom facilities, on huddle/safety boards, etc..

1.6 SIGNING IN WHEN ARRIVING ON SITE

.1 Any contractor worker, subcontractor, or representatives of the consultant and the client on site will receive and sign a form with the following instructions:

.1 Avoid touching your eyes, nose and mouth,

.2 Cough or sneeze into a tissue or the bend of your arm, not your hand,

.3 Dispose of any tissues you have used as soon as possible in a lined waste basket and wash your hands afterwards,

.4 After use, clean and disinfect tools or materials that are shared by more than one person. Use alcohol-based hand sanitizer if soap and water are not available or not possible,

.5 Do not share personal items or supplies such as phones, pens, notebooks, PPE, iPad, etc.,

.6 Refrain from shaking hands with others,

.7 Wash your hands often with soap and water for at least 20 seconds, at least: when you arrive on site; before drinking, eating or smoking; after using the toiler; after handling any tools or materials that might be contaminated, even if wearing gloves; before leaving site.

.8 Ensure physical distancing (at least 2 metres / 6 feet distance) between individuals.

.2 Facility employees not related to construction work are exempt from this and will follow their employee procedures.

.3 At the beginning of each shift, workers will have to respond and sign the following questionnaire:

.1 Have you travelled outside of Canada on or after March 12, 2020 or been in close contact with someone who has?

.2 Are you experiencing the signs/symptoms of COVID-19 such as fever, cough, sore throat, shortness of breath, chills, headache, repeated shaking with chills, muscle pain, new loss of taste or smell, or toes and extremities turning blue?

.3 Have you been in contact with a person showing the symptoms of or tested positive for COVID-19 within the past 14 days?

.4 Anyone answering YES to any of these questions will immediately leave the work site and report to their supervisor.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.

.2 Prepare agenda for meetings.

.3 Distribute written notice of each meeting four days in advance of meeting date to Departmental Representative.

.4 Provide physical space and make arrangements for meetings.

.5 Preside at meetings.

.6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

.7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and, affected parties not in attendance Departmental Representative.

.8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 PRECONSTRUCTION MEETING

.1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.

.3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.

.4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.

.5 Agenda to include:

  .1 Appointment of official representative of participants in the Work.

  .2 Schedule of Work: in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Chart.

  .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.

.4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.

.5 Delivery schedule of specified equipment.

.6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures .

.7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

.8 Departmental Representative provided products.

.9 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.

.10 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.

.11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.

.12 Monthly progress claims, administrative procedures, photographs, hold backs.

.13 Appointment of inspection and testing agencies or firms.

.14 Insurances, transcript of policies.

1.3 PROGRESS MEETINGS

.1 During course of Work and four (4) weeks prior to project completion, schedule progress meetings bi-weekly.

.2 Contractor, major Subcontractors involved in Work and Departmental Representative are to be in attendance.

.3 Notify parties minimum 5 days prior to meetings.

.4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 3 days after meeting.

.5 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of Work progress since previous meeting.

.3 Field observations, problems, conflicts.

.4 Problems which impede construction schedule.

.5 Review of off-site fabrication delivery schedules.

.6 Corrective measures and procedures to regain projected schedule.

.7 Revision to construction schedule.

.8 Progress schedule, during succeeding work period.

.9 Review submittal schedules: expedite as required.

.10 Maintenance of quality standards.

.11 Review proposed changes for affect on construction schedule and on completion date.

.12 Other business.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.

.2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.

.3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.

.4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.

.5 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.

.6 Master Plan: summary-level schedule that identifies major activities and key milestones.

.7 Milestone: significant event in project, usually completion of major deliverable.

.8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.

.9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 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 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 essence of this contract.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit to Departmental Representative within 10 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.

.3 Submit Project Schedule to Departmental Representative within 5 working days of receipt of acceptance of Master Plan.

1.4 PROJECT MILESTONES

.1 Not used.

1.5 MASTER PLAN

.1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).

.2 Departmental Representative will review and return revised schedules within 5 working days.

.3 Revise impractical schedule and resubmit within 5 working days.

.4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.6 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, Samples.

.3 Permits.

.4 Mobilization.

.5 Major equipment delivery

.6 Manifold completion

.7 Structural Steel.

.8 Mechanical shutdowns

.9 Electrical shutdowns

.10 Controls.

.11 Fire Systems.

.12 Testing and Commissioning.

1.7 PROJECT SCHEDULE REPORTING

.1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.

.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.

1.8 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.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

Part 2 Products

.1 Not used.

Part 3 Execution

.1 Not used.

END OF SECTION

Part 1 General

1.1 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 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.

1.2 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 Contractor to illustrate details of a portion of Work.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 5 days for Departmental Representative's review of each submission.

.5 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.

.6 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.

.7 Accompany submissions with transmittal letter, in 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.

.8 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 approval of submissions, verification of field measurements and compliance with Contract Documents.
- .5 Details of appropriate portions of Work as applicable:
  - .1 Fabrication.
  - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
  - .3 Setting or erection details.
  - .4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.9 After Departmental Representative's review, distribute copies.

.10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

.11 Submit electronic copies 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.

.12 Submit electronic copies 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.

.1 Testing must have been within 3 years of date of contract award for project.

.13 Submit electronic copies 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.

.14 Submit electronic copies of manufacturers 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.

.15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.18 Delete information not applicable to project.

.19 Supplement standard information to provide details applicable to project.

.20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, 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.

.21 The review of shop drawings by Departmental Representative is for sole purpose of ascertaining conformance with general 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.

1.3 SAMPLES

.1 Submit for review samples in as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to Departmental Representative's business address.

.3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples 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.

.6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

.1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic digital photography in jpg format, fine resolution monthly with progress statement and as directed by Departmental Representative.

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 2 locations.

  .1 Viewpoints and their location as determined by Departmental Representative.

.4 Frequency of photographic documentation: weekly and as directed by Departmental Representative.

  .1 Upon completion of: demolition, framing and services before concealment of Work, and as directed by Departmental Representative.

1.6 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Compensation Board status.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations

.2 Province of Alberta

  .1 Occupational Health and Safety Act, R.S.A..

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit site-specific Health and Safety Plan: Within 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 Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative weekly.

.4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.

.5 Submit copies of incident and accident reports.

.6 Submit WHMIS MSDS - Material Safety Data Sheets.

.7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within five (5) days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within five (5) days after receipt of comments from Departmental Representative.

.8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

.9 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.

.10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 SAFETY ASSESSMENT

.1 Perform site specific safety hazard assessment related to project.

1.4 MEETINGS

.1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.

1.5 REGULATORY REQUIREMENTS

.1 Do Work in accordance with Section 01 41 00 - Regulatory Requirements.

1.6 PROJECT/SITE CONDITIONS

.1 Work will happen on an active laboratory where solvents and other chemicals are used. The site work should not include contact with any of these chemicals.

1.7 GENERAL REQUIREMENTS

.1 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.

.2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.8 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.

1.9 COMPLIANCE REQUIREMENTS

.1 Comply with Occupational Health and Safety Act, General Safety Regulation, Alberta Reg.

.2 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

1.10 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.

1.11 HEALTH AND SAFETY CO-ORDINATOR

.1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:

.1 This worker only responsibility will be Health and Safety working for the prime contractor.

.2 Have site-related working experience specific to activities associated with laboratories.

.3 Have working knowledge of occupational safety and health regulations.

.4 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.5 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

.6 Be on site at least weekly leading the health and safety toolbox meeting during execution of Work and report directly to and be under direction of Registered Occupational Hygienist or site supervisor.

1.12 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.

1.13 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.

1.14 POWDER ACTUATED DEVICES

.1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

1.15 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

.1 Not used.

Part 3 Execution

.1 Not used.

END OF SECTION

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 friable and non-friable asbestos is hazardous to health. Stop work immediately when material resembling friable and non-friable asbestos that was not previously identified in the Hazardous Building Materials Assessment, May 2019, is encountered during demolition work. Notify Departmental Representative.

.2 Lead: demolition of lead and lead-based paint is hazardous to health. Stop work immediately when material resembling lead or lead-based paint is encountered during demolition work. Notify Departmental Representative.

.3 PCB: Polychlorinated Biphenyl: stop work immediately when material resembling Polychlorinated Biphenyl is encountered during demolition work. Notify Departmental Representative.

.4 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 2 PRODUCTS

.1 Not Used.

Part 3 EXECUTION

.1 Not Used.

END OF SECTION

Part 1 General

1.1 INSPECTION

.1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.

.2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.

.3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.

.4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction.

1.2 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Departmental Representative if the results of tests are positive. Shall the inspector fail the test, the cost of testing will be paid by the contractor.

.2 Provide equipment required for executing inspection and testing by appointed agencies.

.3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.

.4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

1.3 ACCESS TO WORK

.1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.

.2 Co-operate to provide reasonable facilities for such access.

1.4 PROCEDURES

.1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.

.2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.5 REJECTED WORK

.1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.

.2 Make good other Contractor's work damaged by such removals or replacements promptly.

.3 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative.

1.6 REPORTS

.1 Submit 4 copies of inspection and test reports to Departmental Representative.

.2 Provide copies to subcontractor of work being inspected or tested OR manufacturer or fabricator of material being inspected or tested.

1.7 EQUIPMENT AND SYSTEMS

.1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

.2 Refer to technical sections for definitive requirements.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.2 INSTALLATION AND REMOVAL

.1 Provide temporary utilities controls in order to execute work expeditiously.

.2 Remove from site all such work after use.

1.3 WATER SUPPLY

.1 Departmental Representative will provide continuous supply of potable water for construction use.

.2 Arrange for connection with appropriate utility company and pay costs for installation, maintenance and removal.

1.4 TEMPORARY HEATING AND VENTILATION

.1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.

.2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.

.3 Provide temporary heat and ventilation in enclosed areas as required to:

- .1 Facilitate progress of Work.
- .2 Protect Work and products against dampness and cold.
- .3 Prevent moisture condensation on surfaces.
- .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
- .5 Provide adequate ventilation to meet health regulations for safe working environment.

.4 Maintain temperatures of minimum 10 degrees C in areas where construction is in progress.

.5 Ventilating:

- .1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.

.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.

.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.

.4 Ventilate storage spaces containing hazardous or volatile materials.

.5 Ventilate temporary sanitary facilities.

.6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.

.6 Permanent heating system of building, to be used when available. Be responsible for damage to heating system if use is permitted.

.7 On completion of Work for which permanent heating system is used, replace filters.

.8 Maintain strict supervision of operation of temporary heating and ventilating equipment to:

.1 Conform with applicable codes and standards.

.2 Enforce safe practices.

.3 Prevent abuse of services.

.4 Prevent damage to finishes.

.5 Vent direct-fired combustion units to outside.

.9 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.5 TEMPORARY POWER AND LIGHT

.1 Departmental Representative will pay and provide for temporary power during construction for temporary lighting and operating of power tools inside the building, to a maximum supply of 230 volts 30 amps.

.2 Temporary power for electric cranes, contractor trailers, and other equipment requiring in excess of above is responsibility of Contractor and cannot be obtained from the building.

.3 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.

.4 Maximum power supply of 50 kW, minimum, at 208 V, 3 phase, 60 Hz is available and will be provided for construction use at current cost rates. Connect to existing power supply in accordance with Canadian Electrical Code [and provide meters and switching].

1.6 FIRE PROTECTION

.1 Provide and maintain temporary fire protection equipment during performance of Work required by governing codes, regulations and bylaws.

.2 Burning rubbish and construction waste materials is not permitted on site.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.189, Exterior Alkyd Primer for Wood.

.2 CGSB 1.59, Alkyd Exterior Gloss Enamel.

.2 Canadian Standards Association (CSA International)

.1 CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA-0121, Douglas Fir Plywood.

.3 CAN/CSA-S269.2, Access Scaffolding for Construction Purposes.

.4 CAN/CSA-Z321, Signs and Symbols for the Occupational Environment.

.3 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: May 14, 2004.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.3 INSTALLATION AND REMOVAL

.1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.

.2 Identify areas which have to be gravelled to prevent tracking of mud.

.3 Indicate use of supplemental or other staging area.

.4 Provide construction facilities in order to execute work expeditiously.

.5 Remove from site all such work after use.

1.4 SCAFFOLDING

.1 Scaffolding in accordance with CAN/CSA-S269.2.

.2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms and temporary stairs as required to perform the Work.

1.5 HOISTING

.1 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.

.2 Hoists cranes to be operated by qualified operator.

1.6 ELEVATORS

.1 Designated existing elevators to be used by construction personnel and transporting of materials. Co-ordinate use with Departmental Representative.

.2 Provide protective coverings for finish surfaces of cars and entrances.

1.7 SITE STORAGE/LOADING

.1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

1.8 CONSTRUCTION PARKING

.1 Parking will be permitted on site. Department Representative to indicate designated parking and staging area(s).

.2 Provide and maintain adequate access to project site.

1.9 SECURITY

.1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.

1.10 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

.2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

1.11 SANITARY FACILITIES

.1 Contractor will bring their sanitary facilities to be used by contractor personnel.

.2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.12 CONSTRUCTION SIGNAGE

.1 Not permitted.

1.13 PROTECTION AND MAINTENANCE OF TRAFFIC

.1 Provide access and temporary relocated roads as necessary to maintain traffic.

.2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.

.3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs

.4 Protect travelling public from damage to person and property.

.5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.

.6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.

.7 Construct access and haul roads necessary.

.8 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.

.9 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

.10 Dust control: adequate to ensure safe operation at all times.

.11 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.

1.14 CLEAN-UP

.1 Remove construction debris, waste materials, packaging material from work site daily.

.2 Clean dirt or mud tracked onto paved or surfaced roadways.

.3 Store materials resulting from demolition activities that are salvageable.

.4 Stack stored new or salvaged material not in construction facilities.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 INSTALLATION AND REMOVAL

.1 Provide temporary controls in order to execute Work expeditiously.

.2 Remove from site all such work after use.

1.2 HOARDING

.1 Erect temporary site enclosures using 38 x 89 mm construction grade lumber framing at 600 mm centres and 1200 x 2400 x 13 mm exterior grade fir plywood to CSA O121.

.2 Apply plywood panels vertically as indicated.

.3 Provide one lockable truck entrance gate and at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys.

.4 Erect and maintain pedestrian walkways including roof and side covers, complete with signs and electrical lighting as required by law.

.5 Paint public side of site enclosure in selected colours with one coat primer to CAN/CGSB 1.189 and one coat exterior paint to CGSB 1.59. Maintain public side of enclosure in clean condition.

.6 Erect temporary site enclosure using new 1.2 m high snow fence wired to rolled steel "T" bar fence posts spaced at 2.4 m on centre. Provide one lockable truck gate. Maintain fence in good repair.

.7 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.

1.3 GUARD RAILS AND BARRICADES

.1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.

.2 Provide as required by governing authorities and as indicated.

1.4 WEATHER ENCLOSURES

.1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.

.2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.

.3 Design enclosures to withstand wind pressure and snow loading.

1.5 DUST TIGHT SCREENS

.1 Provide dust tight screens or insulated partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.

.2 Maintain and relocate protection until such work is complete.

1.6 ACCESS TO SITE

.1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

1.7 PUBLIC TRAFFIC FLOW

.1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect public.

1.8 FIRE ROUTES

.1 Maintain access to property including overhead clearances for use by emergency response vehicles.

1.9 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

.1 Protect surrounding private and public property from damage during performance of Work.

.2 Be responsible for damage incurred.

1.10 PROTECTION OF BUILDING FINISHES

.1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.

.2 Provide necessary screens, covers, and hoardings.

.3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.

.4 Be responsible for damage incurred due to lack of or improper protection.

1.11 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

Part 2 PRODUCTS

.1 Not Used.

Part 3 EXECUTION

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Within text of each specifications section, reference may be made to reference standards. List of standards reference writing organizations is contained in Section

.2 Conform to these reference standards, in whole or in part as specifically requested in specifications.

.3 If there is question as to whether products or systems are in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.

.4 Cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

1.2 QUALITY

.1 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.

.2 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.

.3 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.

.4 Should disputes arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.

.5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.

.6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.3 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 cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 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.

.8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

.9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.4 TRANSPORTATION

.1 Pay costs of transportation of products required in performance of Work.

.2 Transportation cost of products supplied by Departmental Representative will be paid for by Departmental Representative. Unload, handle and store such products.

1.5 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in specifications, install or erect products 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 writing, 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 re-installation at no increase in Contract Price or Contract Time.

1.6 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.

1.7 CO-ORDINATION

.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.

1.8 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.

1.9 REMEDIAL WORK

.1 Refer Section 01 73 00 - Execution Requirements.

.2 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.

.3 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.10 LOCATION OF FIXTURES

.1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.

.2 Inform Departmental Representative of conflicting installation. Install as directed.

1.11 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 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.

.4 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.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.12 FASTENINGS - EQUIPMENT

.1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

.2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.

.3 Bolts may not project more than one diameter beyond nuts.

.4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.13 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.

1.14 EXISTING UTILITIES

.1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic.

.2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 EXISTING SERVICES

.1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.

1.2 LOCATION OF EQUIPMENT AND FIXTURES

.1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.

.2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

.3 Inform Departmental Representative of impending installation and obtain approval for actual location.

.4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

1.3 RECORDS

.1 Maintain a complete, accurate log of control and survey work as it progresses.

.2 Record locations of maintained, re-routed and abandoned service lines.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit construction phasing plan for the electrical and mechanical systems, with scheduled shutdowns, and update weekly.

.3 Submit written request in advance of cutting or alteration which affects:

- .1 Structural integrity of elements of project.
- .2 Integrity of weather-exposed or moisture-resistant elements.
- .3 Efficiency, maintenance, or safety of operational elements.
- .4 Visual qualities of sight-exposed elements.
- .5 Work of Departmental Representative or separate contractor.

.4 Include in request:

- .1 Identification of project.
- .2 Location and description of affected Work.
- .3 Statement on necessity for cutting or alteration.
- .4 Description of proposed Work, and products to be used.
- .5 Alternatives to cutting and patching.
- .6 Effect on Work of Departmental Representative or separate contractor.
- .7 Written permission of affected separate contractor.
- .8 Date and time work will be executed.

1.2 MATERIALS

.1 Required for original installation.

.2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures.

1.3 PREPARATION

.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.2 After uncovering, inspect conditions affecting performance of Work.

.3 Beginning of cutting or patching means acceptance of existing conditions.

.4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.

.5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 EXECUTION

.1 Execute cutting, fitting, and patching to complete Work.

.2 Fit several parts together, to integrate with other Work.

.3 Uncover Work to install ill-timed Work.

.4 Remove and replace defective and non-conforming Work.

.5 Remove samples of installed Work for testing .

.6 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.

.7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.

.8 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

.9 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.

.10 Restore work with new products in accordance with requirements of Contract Documents.

.11 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

.12 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material full thickness of the construction element.

.13 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.

.14 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

.15 For any work impacting the facility operations:

.1 Re-confirm shutdown approval with the Facilities Manager prior starting the work.

.2 Verify that all the materials required for the work are ready and that their suitability and operation has been verified.

.3 Communicate immediately to the Facilities Manager and the Departmental Representative any issues that might impact the completion of the scheduled work.

.4 Provide, at no charge, temporary solutions to mitigate the impact of the issues at the Facilities Manager or Departmental Representative request.

.5 Inform the Facilities Manager when the work is completed and the users can start using the modified system.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including other than that caused by Departmental Representative or 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, unless approved by Departmental Representative.

.3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.4 Provide on-site containers for collection of waste materials and debris.

.5 Provide and use marked separate bins for recycling. Refer to Section 01 74 19 - Waste Management and Disposal.

.6 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.

.7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.

.8 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

.9 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

.10 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

.1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.

.2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.

.3 Prior to final review remove surplus products, tools, construction machinery and equipment.

.4 Remove waste products and debris other than that caused by Departmental Representative or other Contractors.

.5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.

.6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.

.8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls.

.9 Clean lighting reflectors, lenses, and other lighting surfaces.

.10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.

.11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.

.12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

.14 Remove dirt and other disfiguration from exterior surfaces.

.15 Clean and sweep roofs, gutters, areaways, and sunken wells.

.16 Sweep and wash clean paved areas.

.17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

.18 Clean roofs, downspouts, and drainage systems.

.19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

.20 Remove snow and ice from access to building.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials in accordance with Section 01 74 19 –Waste Management and Disposal.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 GENERAL

1.1 WASTE MANAGEMENT GOALS

.1 Prior to start of Work conduct meeting with Departmental Representative to review and discuss Waste Management Plan and Goals.

.2 Accomplish maximum control of solid construction waste.

.3 Preserve environment and prevent pollution and environment damage.

1.2 DEFINITIONS

.1 Class III: non-hazardous waste - construction renovation and demolition waste.

.2 Inert Fill: inert waste - exclusively asphalt and concrete.

.3 Recyclable: ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse.

.4 Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.

.5 Recycling: process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

.6 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:

    .1 Salvaging reusable materials from re-modelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.

    .2 Returning reusable items including pallets or unused products to vendors.

.7 Salvage: removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.

.8 Separate Condition: refers to waste sorted into individual types.

.9 Source Separation: acts of keeping different types of waste materials separate beginning from first time they became waste.

1.3 STORAGE, HANDLING AND PROTECTION

.1 Store, materials to be reused, recycled and salvaged in locations as directed by Prime Contractor.

.2 Unless specified otherwise, materials for removal become Sub Contractor's property.

.3 Separate and store materials produced during dismantling of structures in areas designated by Prime Contractor.

.4 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with Prime Contractor requirements.

1.4 DISPOSAL OF WASTES

.1 Do not bury rubbish or waste materials.

.2 Do not dispose of waste, volatile materials, mineral spirits, oil, and paint thinner into waterways, storm, or sanitary sewers.

1.5 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises.

.2 Maintain security measures established by existing facility.

1.6 SCHEDULING

.1 Co-ordinate Work with other activities at site to ensure timely and orderly progress of Work.

Part 2 Products

.1 Not Used

Part 3 Execution

1.1 APPLICATION

.1 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

1.2 CLEANING

.1 Remove tools and waste materials on completion of work and leave work area in clean and orderly condition.

.2 Clean-up work area as work progresses.

.3 Source separate materials to be reused/recycled into specified sort areas.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

.1 Contractor's Inspection: Contractor conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.

.2 Request Departmental Representative inspection.

.2 Departmental Representative Inspection:

.1 Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.

.2 Contractor to correct Work as directed.

.3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:

.1 Work: completed and inspected for compliance with Contract Documents.

.2 Defects: corrected and deficiencies completed.

.3 Equipment and systems: tested, adjusted and balanced and fully operational.

.4 Certificates required by Fire Commissioner and Utility companies: submitted.

.5 Operation of systems: demonstrated to Departmental Representative's personnel.

.6 Commissioning of mechanical systems: completed in accordance with 01 91 13 - General Commissioning (Cx) Requirements and TECHNICAL SECTIONS and copies of final Commissioning Report submitted to Departmental Representative.

.7 Work: complete and ready for final inspection.

.4 Final Inspection:

.1 When completion tasks are done, request final inspection of Work by Departmental Representative, and Contractor.

.2 When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.

1.2 FINAL CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Pre-warranty Meeting:

.1 Convene meeting one week prior to contract completion with contractor's representative and Departmental Representative, in accordance with Section 01 31 19 - Project Meetings 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.

.3 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 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of operating and maintenance manuals in English.

.3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.

.4 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

.1 Organize data as instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used correlate data into related consistent groupings.

.1 Identify contents of each binder on spine.

.4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab.

.1 Bind in with text; fold larger drawings to size of text pages.

.9 Provide 1:1 scaled CAD files in dxf format on CD.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume: provide title of project;

.1 Date of submission; names.

.2 Addresses, and telephone numbers of Departmental Representative and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data.

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

.6 Training: refer to Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

1.5 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 report, system components list c/w commissioning verification forms and check sheets and commissioning issues/resolution log.

.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.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line drawings, and in copy of Project Manual, provided by Departmental Representative.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

.7 Provide digital photos, if requested, for site records.

.8 At the end of construction provide As-Built CAD drawings.

1.7 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts.

.1 Give function, normal operation characteristics and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 - General Commissioning (Cx) Requirements.

.15 Additional requirements: as specified in individual specification sections.

1.8 MATERIALS AND FINISHES

.1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.

.2 Provide information for re-ordering custom manufactured products.

.3 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.5 Additional requirements: as specified in individual specifications sections.

1.9 MAINTENANCE MATERIALS

.1 Spare Parts:

.1 Provide spare parts, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to [site] [location as directed]; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Departmental Representative.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

.2 Extra Stock Materials:

.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Departmental Representative.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

.3 Special Tools:

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Departmental Representative.

.2 Include approved listings in Maintenance Manual.

1.10 DELIVERY, STORAGE AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by Departmental Representative.

1.11 WARRANTIES AND BONDS

.1 Develop warranty management plan to contain information relevant to Warranties.

.2 Submit warranty management plan, [30] days before planned pre-warranty conference, to Departmental Representative approval.

.3 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.

.4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

.5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.

.6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

  .1 Separate each warranty or bond 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 and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within [ten] 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 and bonds until time specified for submittal.

.7 Except for items put into use with Departmental Representative's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.8 Conduct joint [4] month and [9] month warranty inspection, measured from time of acceptance, by Departmental Representative.

.9 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include HVAC balancing, motors, transformers, and commissioned systems such as sprinkler systems.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at [4] and [9] month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.10 Respond in timely manner to oral or written notification of required construction warranty repair work.

.11 Written verification to follow oral instructions.

.1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.12 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate following information on tag:

.1 Type of product/material.

.2 Model number.

.3 Serial number.

.4 Contract number.

.5 Warranty period.

.6 Inspector's signature.

.7 Construction Contractor.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

.1 Consultant will provide:

.1 Descriptions of systems.
.2 Instruction on design philosophy, design criteria, and design intent.

.2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:

.1 Start-Up, operation, shut-down of equipment, components and systems.
.2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
.3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.

.3 Contractor and equipment manufacturer to provide instruction on:

.1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING OBJECTIVES

.1 Training to be detailed with suitable duration to ensure:

.1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
.2 Effective on-going inspection, measurements of system performance.
.3 Proper preventive maintenance, diagnosis and trouble-shooting.
.4 Ability to update documentation.
.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Training materials to include:

.1 "As-Built" Contract Documents.
.2 Operating Instructions.
.3 Maintenance Manual.
.4 Management Manual.
.5 Testing, Adjusting and Balancing and Performance Verification Reports.

.3 Project Manager, Commissioning Manager and Facility Manager will review training materials.

.4 Training materials to be in a format that permits future training procedures to the same degree of detail.

.5 Supplement training materials:

.1 Multimedia presentations.
.2 Manufacturer's training videos.
.3 Equipment models.

.6 Training materials with agendas to be made available prior to scheduling training sessions.

1.6 SCHEDULING

.1 Include in Commissioning Schedule time for training.

.2 Deliver training during regular working hours, training sessions to be adequate in length for each system to meet the training objectives.

.3 Training to be completed prior to acceptance of facility.

1.7 RESPONSIBILITIES

.1 Be responsible for:

.1 Implementation of training activities,
.2 Coordination among instructors,
.3 Quality of training, training materials,

.2 Upon completion of training, provide written report, signed by Instructors, and Trainees, witnessed by Departmental Representative.

.3 Commissioning Manager will evaluate training agendas, materials, reporting and signed sheets / attendance logs and then verify the training process completion.

1.8 TRAINING CONTENT

.1 Training to include demonstrations by Instructors using the installed equipment and systems.

.2 Content includes:

.1 Review of facility and occupancy profile.
.2 Functional requirements.
.3 System philosophy, limitations of systems and emergency procedures.
.4 Review of system layout, equipment, components and controls.
.5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
.6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
.7 Maintenance and servicing.
.8 Trouble-shooting diagnosis.
.9 Inter-Action among systems during integrated operation.
.10 Review of O&M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 This section includes the Initial Project Commissioning Plan, describing the overall commissioning process structure along with the roles and responsibilities of the commissioning team.

.2 The commissioning plan is a dynamic document that will be updated as commissioning progresses and milestones are achieved, or as the commissioning program is amended.

.2 Related Requirements

.1	Demonstration and Training for Building Commissioning	Section 01 79 00.13
.2	General Commissioning Requirements	Section 01 91 13
.3	Commissioning Forms	Section 01 91 13.16

1.2 PROJECT SUMMARY

.1 The Canadian Food Inspection Agency (CFIA) Lethbridge Laboratory has not had any major equipment upgrades since it was constructed in 1984. This project was approved by the need to replace the air handlers and associated equipment, with the added goals of increasing air handler redundancy, ventilation efficiency, and humidification consistency. A decision has been made to replace the existing air handling units in phases and to add interconnections that allow for unit back up.

1.3 IMPORTANCE OF THE COMMISSIONING PLAN

.1 The Commissioning Plan is the master planning document for commissioning and is addressed to all members of the Commissioning Team. It provides an overview of commissioning, a general description of all elements that make up the Commissioning Program and sets out the process and the methodology for successful commissioning of the above-mentioned project.

1.4 PURPOSE OF THE COMMISSIONING PLAN

.1 The Commissioning Plan functions as a management tool, setting out the commissioning scope, standards, and roles and responsibilities of each member of the Commissioning Team and deliverables.

.2 The Commissioning Plan also functions as a communications tool, informing each member of the Commissioning Team, in general terms, of their own roles and responsibilities and those of the other members of the Commissioning Team.

1.5 COMPOSITION, ROLES AND RESPONSIBILITIES OF THE COMMISSIONING TEAM

.1 The Commissioning Team will consist of the following (see also the Org Chart in Appendix A):

.2 Departmental Representative: As assigned by PSPC, has overall responsibility for managing the project on behalf of the User Group (Public Services and Procurement Canada {PSPC}).

.3 Commissioning Process Manager: Has overall responsibility for the development, implementation and management of commissioning, planning and preparation of commissioning forms, approval of operation of systems, commissioning results and reports. Provision of advice relating to operational perspectives by working closely with all other members of the Commissioning Team. Is responsible for monitoring all commissioning activities, owner training and distribution of commissioning documentation.

.4 Consultant: Has the responsibility for producing the project Basis of Design Report. The Consultant (referred to in this document as the Design Team) prepares construction documents including the testing and start-up specifications coordinating them with the commissioning specifications. Provides also the building design controls sequences of operation and reviews the progress of the construction. Consultant also is to review, approve and sign-off all submittals before and after execution by the contractor.

.5 Contractor: This term includes sub-trades and suppliers. The Contractor has responsibility for performance of commissioning activities, including installation, start-up and fine tuning of the systems, delivery of training and all commissioning documentation. For administrative and coordination purposes, the Contractor assigns one person as the point of contact with the Design Team and the Commissioning Process Manager CxPM.

.6 Commissioning Agents: Working under the CxPM will carry out, commissioning field reviews and report observations through commissioning reports.

.7 Property (Facility) Manager: Has responsibility for receiving the renovated facility. This person is responsible for day-to-day operation and maintenance of the facility and represents the lead role in the Operation Phase and onwards. Provides input to the commissioning process as may be required from time to time.

1.6 RISK ASSESSMENT

.1 The Department Representative to prepare the initial Risk Management Plan. Noted items to date:

  .1 Available Reverse Osmosis Water Supply – New RO equipment upgrades are now to be installed as part remediation work at Building 14E.

  .2 Available Emergency Power / Existing Emergency Generator Capacity – It has now been determined that the expected combined loads from Buildings 14E and 14W will load the existing generator to 80-85% of capacity, which meets the code requirement.

  .3 Communication Wiring – This project will provide raceways and outlets for future data cabling to work benches. Shared Services Canada will be responsible for wiring and final connections.

1.7 OBJECTIVE OF COMMISSIONING

.1 Commissioning Program to provide a fully functional facility within design parameters:

.1 Whose systems, equipment and components have been proven to meet all User's functional requirements before the date of acceptance, and operate consistently at peak efficiencies and within specified sequences of operation under normal loads

.2 In which the O&M personnel will have been fully trained in all aspects of all installed systems

.3 Having complete documentation relating to all installed equipment and systems

1.8 DESIGN CRITERIA, DESIGN INTENTS, OPERATING PARAMETERS

.1 The Architectural, Mechanical and Electrical Consultant's Basis of Design Concepts are included in Appendix B, and where prepared as part of the Design Development Report for this project.

1.9 EXTENT OF COMMISSIONING

.1 Systems to be commissioned shall include, new and any relocated components related to:

.1 Mechanical

.1 New HVAC Systems / Equipment
.1 New Air Handling Units
.2 New Return Fans
.3 New Reverse Osmosis Unit
.4 New Humidification Boiler

.2 Electrical

.1 Power Distribution (new panelboards, branch circuits, receptacles)
.1 New 120 Circuit Panelboard
.2 New 60 Circuit Emergency Power Panelboard

.3 Building

.1 Building Integrated Systems Test

.4 Systems that do not fall under the commissioning program:

.1 Fire Alarm - Fire Alarm VI is through the Electrical Engineer
.2 Sprinkler System - The Sprinkler work at this time consists only of relocated heads and is to be signed off by the Fire Protection Engineer through his C-2 Certificate

1.10 PROJECT MILESTONES

.1 The project is presently at the Design Stage with the following anticipated milestones dates (several to be confirmed):

.1 Consultant Contract Award – Complete
.2 Design Development – Complete
.3 66% Construction Drawings – Complete
.4 99% Construction Drawings – Complete
.5 100% Construction Drawings – To Be Confirmed
.6 Tender Close – To Be Confirmed

.7 Construction Award –
.8 Substantial Completion –
.9 Final Commissioning Completion –
.10 Warranty Evaluation –

1.11 CONTRACTOR DELIVERABLES RELATING TO O&M PERSPECTIVES

.1 Maintenance Manual

.1 This will be produced by the Contractor as construction/installation proceeds, in a format as directed by the project specifications. The Manual is to be reviewed, approved and signed-off by the Design Team. It is to be 90% complete prior to start-up activities.

.2 Systems Operations Manual

.1 The systems operation manual and Standard Operating Procedures (SOPs) will be produced by the Contractor in conjunction with the Maintenance Manual, as construction/installation proceeds, in a format as directed by the project specifications. The Manual is to be reviewed, approved and signed-off by the Design Team. It is to be 90% complete prior to start-up activities.

.3 Warranties

.1 A complete inventory to be provided by the Contractor in the Maintenance Manual for the Design Team and Commissioning Manager to review, approve and sign-off.

.4 "As-built" Drawings and Specifications

.1 These will be produced by the Design Team from the project record documents maintained on the site and kept up-to-date with all changes marked thereon by the Contractor. Accuracy will be verified by the Design Team before preparation of the "As-builts" and by the Commissioning Manager based on reviews of the red-line drawings before submission. They shall be completed in time to be used during commissioning reviews.

.5 Training Plan

.1 The Contractor will be responsible for Owner training, while the Commissioning Process Manager will monitor all training activities including reviews of training agenda and outlines. The Contractor will be responsible for implementation of training activities, quality of instruction and training materials and for coordination among the instructors.

1.12 DELIVERABLES RELATING TO THE COMMISSIONING PROCESS

.1 Deliverables and production of related documentation will be outlined in the project specifications with input from the Commissioning Process Manager and will include items such as:

.1 Assign an individual to act as the Contractor’s Cx Coordinator, responsible for coordination of all Cx Activities, including documentation and reporting on progress.

.2 Conduct Pre-start-up tests during construction. These will include flushing, cleaning, "bumping", etc. The completed documentation will be provided to the Commissioning Process Manager and retained within the commissioning program with the Commissioning Report.

.3 Static Installation / Pre-functional start-up reviews conducted by the Design Team prior to permission to start up, along with rectification of all installation deficiencies to the satisfaction of the Design Team and Commissioning Process Manager.

.4 Start-up: This will be by the Contractor (may also include equipment manufacturer, supplier and/or installing specialist sub-contractor) under the direction of the Design Team. It will also include rectification of all start-up deficiencies by the Contractor to the satisfaction of the Design Team and CxPM.

.5 TAB and functional performance verification will be performed by the approved Agencies, repeated where necessary until results are acceptable to the Design Team. Procedures will be as per industry standard but modified to suit project requirements. Reported results will be witnessed and certified by the Design Team and Commissioning Agents. Final Test and Balance Reports to be approved and signed-off by the Design Team and provided to the Project Manager. All activities will be monitored by the CxPM.

.6 Commissioning Report – The CxPM will compile all completed commissioning documentation including: Static Installation / pre-functional checks, start-up tests, TAB report, component functional performance testing and integrated system tests into a final commissioning report including an executive summary.

.7 The final report will also include a Cx Issues and Resolution Log along with Lesson's Learned Documentation (as may be applicable).

.2 Commissioning Specifications

.1 Commissioning specifications will summarize the contractor's requirements related to the Commissioning Plan. Final edited versions will be prepared by the Design Team during the working document stage. The specification will include copies of all proposed Commissioning Checksheets and forms for reference.

.3 Component Verification / Product Information Commissioning Forms

.1 Component Verification / Product Information forms specific to this project will be developed by the Commissioning Process Manager prior to project tender. After the approval of shop drawings for the equipment concerned, a final edited set of the commissioning forms will be input into the online digital commissioning program and provided to the Project Manager for review. Instructions for use will be included by the CxPM and online within the Cx Software. The commissioning sheets are intended to monitor and track the supply and installation requirements associated with each component. All completed Component Verification / Product information forms will be documented by the Contractor and monitored by the CxPM. The completed forms will be included in the final commissioning report.

.2 The commissioning forms will also include checks on system integration and performance, to capture data on balancing, local controls and fit-out system interface with Base Building Systems. At the conclusion of individual system commissioning, an Integrated Building Systems Test will confirm the Building 14E systems integration under emergency operating conditions.

.4 Commissioning Reports

.1 Following all field reviews by the Commissioning Agents, reports will be issued noting observations and identifying any issues requiring action. An Issues Log will be created and will track all noted commissioning action items to confirm that issues have been addressed. This log will be available online for all project team members to access. A final commissioning summary log will be prepared at the end of the project to provide an overview of all issues and actions taken to sign-off each item.

1.13 SCHEDULING OF COMMISSIONING ACTIVITIES

.1 Commissioning Schedules

.1 Reviews and Approvals: Commissioning will be organized so that there will be no delays in the review and approvals process. Where practical, commissioning activities will overlap with the Contractor's start-up and testing plan, such as reviewing the balancing as the balancing agent is wrapping up his work on site.

.2 Commissioning Activities Scheduling

.3 A detailed schedule will be prepared jointly by the Commissioning Manager and the Contractor Cx Coordinator and submitted to Project Manager for review and approval at the same time as the preliminary Construction and Completion Schedule. After approval, it will be incorporated into the Contractor's Construction and Completion Schedule. The Design Team, CxPM, Contractor and Project Manager will monitor progress of commissioning against this schedule.

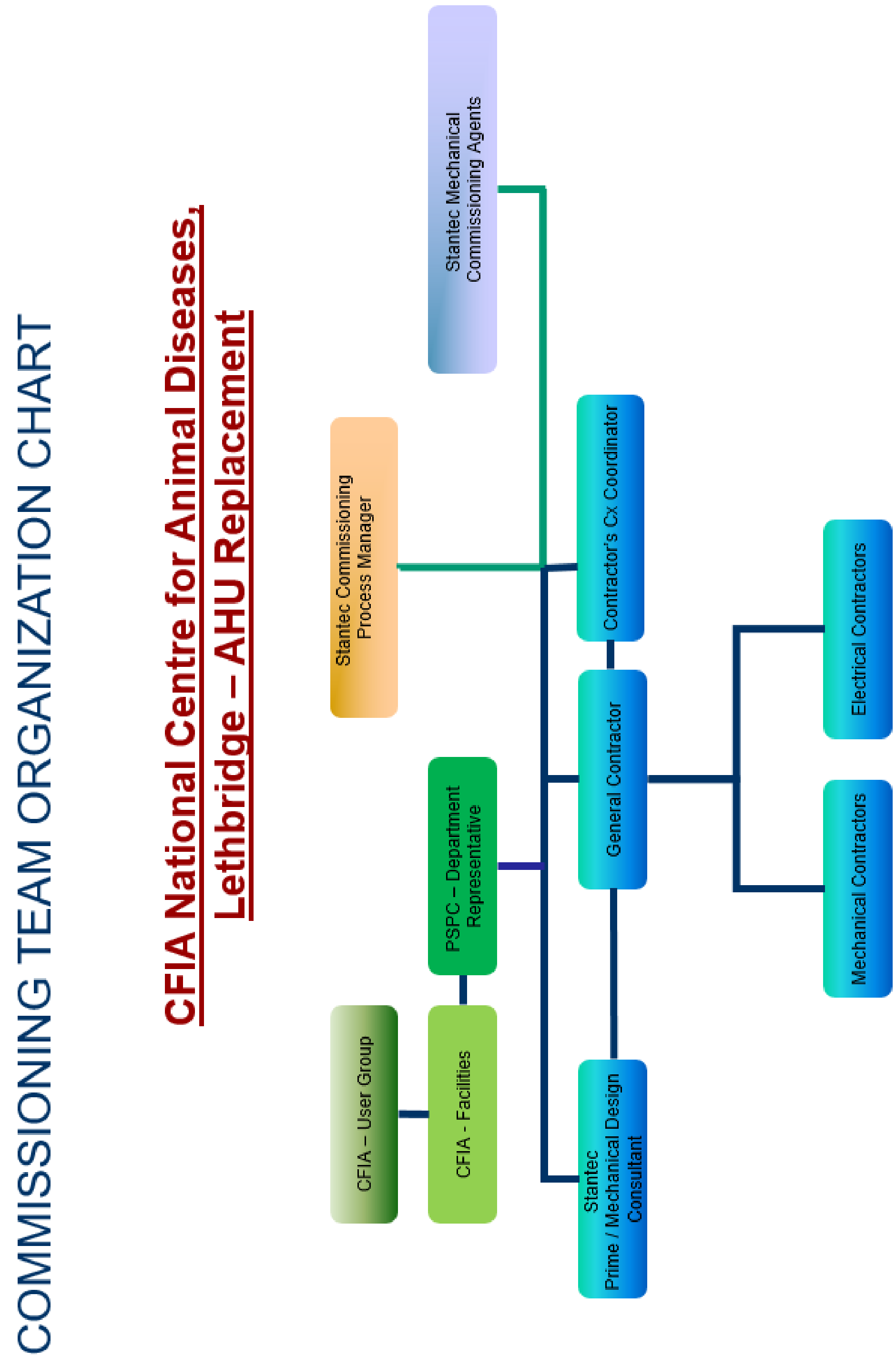
.4 This schedule to also include timelines for training so as to demonstrate that there will be no conflicts with testing.

1.14 COMMISSIONING COST ESTIMATE

.1 The total cost estimate based on the present commissioning scope is $8,000

.1 Mechanical Discipline Scope ≈ $5,000
.2 Electrical Discipline Scope ≈ $3,000

Appendix A – Commissioning Team Organization Chart



END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Commissioning forms to be completed for equipment and systems.

.2 Related Requirements

.1	Demonstration and Training for Building Commissioning	Section 01 79 00.13
.2	General Commissioning Requirements	Section 01 91 13
.3	Commissioning Plan	Section 01 91 13.13

1.2 VENDOR INSTALLATION/START-UP CHECK SHEETS

.1 Include the following data:

.1 Product manufacturer's technical data and recommended checks.
.2 Special procedures as specified in relevant technical sections.
.3 Items considered for good installation, and engineering industry practices deemed appropriate for proper and efficient operation.

.2 Equipment manufacturer's installation/start-up check sheets are acceptable for use. As deemed necessary by Departmental Representative, supplemental additional data lists will be required for specific project conditions.

.3 Use check sheets for equipment installation. Complete check sheets to verify checks have been made, indicate deficiencies and the corrective action taken.

.4 Installer to sign check sheets upon completion, certifying stated checks and reviews have been performed. Return completed check sheets to Departmental Representative and Commissioning Manager. Check sheets will be required during Commissioning and will be included in Commissioning Checklist Program and Building Maintenance Manual (BMM) at completion of project.

.5 Use of check sheets will be included as part of commissioning process and will be stringently used for equipment pre-start and start-up procedures.

1.3 COMMISSIONING (CX) FORMS / CHECK SHEET PROGRAM (CXALLOY)

.1 The Commissioning (Cx) Check Sheet program for this project is an online web-based program. Electronic Mechanical and Electrical checklists are developed by the Commissioning Manager within this program to document the specific commissioning activities required. The check sheets are organized into individual systems specific to each discipline and indexed by equipment type.

.2 The Commissioning Check Sheets are designed to act as a tool for the Contractor to ensure the installed equipment matches the information on the approved shop drawings and that each installation is properly completed before start-up to reduce the number of deficiencies associated with system start-ups.

.3 The Contractor shall complete Commissioning Check Sheets to verify that the equipment installed adheres to the design requirements, matches the approved shop drawings and is installed as required. Later, functional performance reviews will also to be documented.

.4 The Commissioning Manager will review with the contractor to confirm the data entries are complete and correct along with documenting any deficiencies observed. When all deficiencies are resolved, and the piece of equipment is operating as designed, the Commissioning Manager will sign off and finalize these forms

.5 All deficiencies noted during commissioning reviews will be logged directly onto the check sheets which is linked to the Cx Issues & Resolutions Log. Live, up to date tracking of all issues including, 'Open', 'In Progress', 'Pending Sign-off' and 'Closed' issues can be easily filtered and are accessible to all Commissioning Team Members.

.6 Equipment Attributes (Technical Data) - Shop drawing information will be provided in the attributes section of the equipment check sheets included in the online commissioning program CxAlloy for reference during field commissioning. Contractor is to confirm the installed equipment matches its attributes and complete this portion of the checklist associated with each piece of equipment

.7 Static Installation (Pre-Functional) Checks - Contractor to notify the Commissioning Manager when the installation of the equipment or system is substantially complete. The Contractors are to complete all pre-functional checks and update the equipment (install in progress, install complete, start-up completed, testing & fine tuning complete) and associated check sheet (technical data captures, static checks complete, operational checks complete) work flow status accordingly. The Cx Agents will verify the Contractor completed checks.

.8 Operation Checks - Contractor documents that equipment and systems are operating as intended on the check sheets. System tests are documented by the Contractors and verified by the Commissioning Agents as field reviews of the equipment / systems progress.

.9 FUNCTIONAL PERFORMANCE VERIFICATION (FPV) CHECKS

  .1 FPV forms to be used for running dynamic tests and adjustments carried out on equipment and systems to ensure correct efficient operation, and function independently and interactively with other systems as intended with project requirements.

  .2 FPV report forms include those developed by Commissioning Manager and Contractor to record measured data and readings taken during functional testing and Performance Verification procedures.

  .3 Control Contractors shall verify all control sensor / device installations and calibration. Field verifications shall be documented and available with a Commissioning Manager section for additional BMS and field measured values, along with signature block for Commissioning Manager acceptance and sign-off.

  .4 The Commissioning Manager and Controls Contractor shall develop test scripts upon approval of the Contractors Shop Drawing Submittal utilizing the finalized sequences of operation.

.5 Contractors shall identify required updates to the test procedures and provide required updates in a timely manner.

.6 Prior to FPV of integrated systems, complete FPV forms of related systems and obtain Consultant and Commissioning Manager approval.

1.4 SAMPLES OF COMMISSIONING FORMS

.1 Commissioning Manager will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.

.2 Revise items on Commissioning forms to suit project changes when required.

.3 Samples of Commissioning forms are appended to the end of this specification section. A complete index of produced to date check sheet forms will be attached to Commissioning Plan as it further develops, as outlined within the Commissioning Forms Specification Section 01 91 13.16.

1.5 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

.1 When additional forms are required but are not available from Departmental Representative or Commissioning Manager, develop appropriate verification forms and submit to Departmental Representative and Commissioning Manager for approval prior to use.

1.6 COMMISSIONING FORMS

.1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

.2 Strategy for Use:

.1 Commissioning Manager provides Contractor project-specific Commissioning forms with equipment technical data included.

.2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.

.3 Confirm operation as per design criteria and intent.

.4 Identify variances between design and operation and reasons for variances.

.5 Verify operation in specified normal and emergency modes and under specified load conditions.

.6 Record analytical and substantiating data.

.7 Verify reported results.

.8 Digital web-based commissioning forms developed by the Commissioning Manager provide user entered data digital date and time stamps. Forms not developed by the Commissioning Manager are to bear dates and signatures of recording technician(s) when completed and are to be reviewed and signed off by Departmental Representative and Commissioning Manager.

.9 Submit immediately after tests are performed.

.10 Reported results in true measured SI unit values.

.11 Provide Commissioning Manager with originals of any additional check sheets or forms, not developed by the Commissioning Manager

.12 All critical information can be communicated and accessed instantly using the commissioning software, CxAlloy.

.13 Documentation will be posted online and easily accessible with any internet browser and/or mobile device such as iPads or smart phones.

1.7 LANGUAGE

.1 To suit the language profile of the awarded contract.

Part 2 Products

2.1 COMMISSIONING PROGRAM

.1 CxAlloy provides all project team members with real-time updates on all commissioning activities and highlights progress from the start of the project through construction to close-out. Systems and equipment static installation / pre-functional and functional performance check-sheets can be remotely accessed by all project stakeholders. An application is also available for free download, allowing any team member to view current project commissioning status from any mobile device.

.2 Commissioning program, forms / check sheets, reporting and associated issues logs are all located and remotely accessible through the web-based commissioning program and free application download.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

EQUIPMENTS

Sample AHU-2

Stantec Consulting |
114740xxx

START-UP COMPLETE

1 CHECKLIST | 0 TESTS | 2 ISSUES

Sample air System c/w Humidifier

Space Mechanical Room
Type Air Handling Unit
Discipline Mechanical

Systems 1

Name	Description	Building	Discipline
Ventilation - Sample AHU			

Attributes 18

# of Heating Coil Rows 2 x Glycol Coil Rows
# of Return Fans 1
# of Supply Fans 1
Air Filters MERV 8
Exhaust Air Damper? Yes, Insulated
Humidifier? Yes, HU-2
Manufacturer Trane
Mixed Air Damper? Yes
Model TRANE Performace Climate Changer Air Handler CSAA021UAL00
Outdoor Air Damper? Yes, Insulated
Return Fan Airflow 4420 L/s
Return Fan Electrical (V/Ph/Hz) 208/3/60
Return Fan Model Comefri ATZAF 22-22
Return Fan Motor Horsepower 5 HP (23.5 MCA)
Supply Fan Airflow 4420 L/s
Supply Fan Electrical (V/Ph/Hz) 208/3/60
Supply Fan Model Comefri ATZAF 22-22
Supply Fan Motor Horsepower 7.5 HP (35 MCA)

Issues 2

Number	Description	Status	Priority	Asset	Assigned	Due Date
FO-2-3	AHU-2 - No belt guards at the supply fan.	CLOSED	MODERATE	AHU-2	Mechanical Contractor	2/15/2018
FO-2-4	AHU-2 - The Supply Fan VFD is with only a NEMA-1 cover, and will require a drip shield added.	CLOSED	LOW	AHU-2	Mechanical Contractor	11/29/2017

Checklists 1

Name & Type	#	Status	Progress	Issues	Sections
AHU-X Cx Review	2	TECHNICAL DATA CAPTURED		0 ISSUES	1

Stantec

CHECKLIST

#2 AHU-2

Stantec Consulting |
114740xxx

Type Cx Review
Asset AHU-2

Sections 1

Equipment Attributes, Static & Operational Checks

EQUIPMENT ATTRIBUTE CHECKS

1 Contractor to confirm correct equipment Manufacturer and Model is installed.

2 Contractor to confirm correct supply fan Manufacturer and Model are installed.

3 Contractor to confirm correct return fan Manufacturer and Model are installed.

4 Contractor to confirm the installed equipment matches the requirements of the approved shop drawings and contract
documents?

UNIT STATIC CHECKS

5 Are the cabinet / access doors in good condition and free of obstruction?

6 Are the correct filters installed and in good condition?

7 Are all duct / flex connections in good condition?

8 Duct insulation fastened and leading edges sealed?

9 Insulated outdoor air damper installed and in good condition?

10 Return air damper installed and in good condition?

11 Insulated exhaust air damper installed and in good condition?

12 Static pressure taps available?

13 All applicable coils are installed and in good condition with sufficient pull space?

14 Humidification section installed and in good condition with sufficient service space?

15 Airflow stations installed?

16 Filter gauge(s) installed?

17 Unit cabinet drip / condensate drain piping & traps complete?

18 Unit cabinet M&E penetrations sealed with rubber grommets and retaining plates?

SUPPLY FAN(S) STATIC CHECKS

19 Is the fan housing sealed and free of damage?

20 Correct fan arrangement?

21 Is the fan alignment correct?

22	Is a local disconnect installed?
23	Vibration isolation provided and set up?
24	Are all fan and flex connections in good condition?
25	Fan safe guards in place? (Belt Guard / Discharge / Inlet Screens)
26	Sufficient service & removal space?

RETURN FAN(S) STATIC CHECKS

27	Is the fan housing sealed and free of damage?
28	Correct fan arrangement?
29	Is the fan alignment correct?
30	Is a local disconnect installed?
31	Vibration isolation provided and set up?
32	Are all fan and flex connections in good condition?
33	Fan safe guards in place? (Belt Guard / Discharge / Inlet Screens)
34	Sufficient service & removal space?

COIL(S) STATIC CHECKS

35	Is all piping completed as intended? Refer to appropriate schematics & detail drawings.
36	High point air vent(s) installed?
37	Low point drain installed?
38	Control valve(s) correct?
39	Isolation valves installed to accommodate service & maintenance?
40	Coil(s) in good condition?
41	Temperature taps installed?
42	Balancing valve(s) installed?
43	Flow meter(s) installed?

HUMIDIFICATION SECTION STATIC CHECKS

44	Is all (steam / water) supply piping complete and correct? Refer to appropriate schematics & detail drawings.
45	Is all (condensate / water) drain piping complete? Refer to appropriate schematics & detail drawings.
46	Isolation valves installed to accommodate service & maintenance?
47	Control valve(s) correct?
48	Correct humidification grid installation?

OPERATION CHECKS

49	All fan rotations are correct, along with bypass at VFD?

✓	✗	N/A	50	Mixed air stratification?
✓	✗	N/A	51	No notable air leakage?
✓	✗	N/A	52	No notable sound / vibration?
✓	✗	N/A	53	System operation and controls functioning correctly? (Refer to appropriate BMS Controls test section)
✓	✗	N/A	54	Unit balancing complete?
✓	✗	N/A	55	Vendor startup report received (if applicable)?
✓	✗	N/A	56	Safety switch at door to Electric Final Filters in operation?

TEST

#2 Sample - Air System AHU-2

Stantec

114740xxx

Asset Ventilation - Sample

Attempts 1

Attempt No. 1

AIR HANDLING UNIT AHU-2 SUPPLIES AIR TO THE GYMNASIUM AND COMES WITH A MIXED AIR DAMPER. AHU-2'S HEATING AND COOLING MODE IS DETERMINED BY CALENDAR, SCHEDULE, OUTDOOR AIR TEMPERATURES AND TEH SPACE TEMPERATURE TO DETERMINE THE BEST MODE. SUPPLY AIR TEMPERATURE TO BE SET AT 18°C FOR DISPLACEMENT VENTILATION.

PREREQUISITES

Yes | No | N/A	1	Air Balancing is complete?
Yes | No | N/A	2	Have the BAS Control Points been verified?
Yes | No | N/A	3	Are the BMS graphics complete?
Yes | No | N/A	4	VFD start-up report has been submitted?
Yes | No | N/A	5	Duct cleaning complete?

VERIFY THE FOLLOWING SEQUENCE OF OPERATION

START-UP

WHEN ENABLED BY CALENDAR, SCHEDULE, NIGHT SETBACK, OPTIMAL START OR MANUAL OVERRIDE CONTROL. THEN:

Yes | No | N/A	6	When in heating mode, and start-up implement a 3 minute time delay (adjustable) to warm up the heating coil prior to enabling the supply fan.

AIR HANDLING UNIT AHU-2 PREHEAT AND HEATING COIL VALVES

Yes | No | N/A	7	The heating coil valve shall modulate to maintain supply air temperature during the heating season.
Yes | No | N/A	8	Freeze Condition - On a low temperature condition (35 Deg F) the heating coil shall go to full heating, fans will be off and dampers go to 100% Return Air.
Yes | No | N/A	9	Enabling the exhaust allows the outdoor air damper to open.
Yes | No | N/A	10	When the outdoor air damper end switch is indicating fully opened, the supply fan is enabled and speed is controlled.
Yes | No | N/A	11	The supply air flow setpoint is Constant
Yes | No | N/A	12	The exhaust fan startup is enabled after the supply fan has been proven for 30 seconds.
Yes | No | N/A	13	The exhaust fan will not be enabled until the hard wired damper end switch proves the exhaust air damper is fully open.
Yes | No | N/A	14	The exhaust fan speed is slowly ramped up and controlled to the exhaust air setpoint which is 95% of S-Fan speed

AIR FLOW CONTROL

Yes | No | N/A	15	Minimum outdoor air damper position is to maintain latest ASHRAE Standard 62 for minimum outdoor air damper position setpoint.

Yes | No | N/A	16	Average two building to outdoor air pressure differential sensors to control the speed of the exhaust fan and to provide a slight positive pressure. Initial building to outdoor air pressure setpoint set to an adjustable 25 Pa.
Yes | No | N/A	17	Supply and exhaust fan speed is controlled by an input from the air flow sensors. Fan speed is controlled to maintain supply and exhaust air flow setpoints.
Yes | No | N/A	18	The exhaust fan speed is controlled to and supply to exhaust flow offset. Maintain a slightly positive pressure throughout the building.
HEATING AND COOLING CONTROL		
Yes | No | N/A	19	When in heating mode, and the source of heating is the mixed air damper, and the heating coil to maintain supply air temperature set point.
Yes | No | N/A	20	When the mixed air damper control is unable to maintain temperature setpoint at minimum outdoor damper position, then the heating coil valve is modulated to maintain supply air temperature setpoint.
Yes | No | N/A	21	Gymnasium also has perimeter radiant finned heating and maintains night space temperature setpoint during occupied hours when AHU-2 is off.
Yes | No | N/A	22	If air handling unit is unable to keep up with heating demand, then radiant heating to gymnasium to be provided.
Yes | No | N/A	23	The free cooling to maintain suitable indoor conditions until the outdoor air temperature is above 16°C.
HUMIDITY CONTROL		
Yes | No | N/A	24	An outdoor air humidity and temperature sensor is used as reference to determine required humidity inside of the school and scale value as following: O/A Temp.----------Return Air Humidity Setpoint -35°C----------------20% 15°C-----------------40% An alarm is generated if space humidity is above 65% RH for greater than 30 minutes.
Yes | No | N/A	25	Humidity is generated by a gas fired humidifier HU-2.
Yes | No | N/A	26	When outdoor air humidity is higher than supply air humidity setpoint, disable humidifier HU-2.
Yes | No | N/A	27	Enable humidifier HU-2 if return air humidity is 10% RH below % RH setpoint.
Yes | No | N/A	28	When HU-2 is enabled, keep the AHU maximum supply air humidity setpoint at 70% RH (adjustable).
Yes | No | N/A	29	AHU maximum return air humidity setpoint alarm of 75% RH, minimum return air humidity setpoint alarm of 15%.
SYSTEM TURNOVER		
Yes | No | N/A	30	Are there any applicable extended warranties with the equipment in this system?

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements relating to commissioning of project's new construction components and systems, specifying general requirements to verify performance of components, equipment, sub-systems, systems, and integrated systems.

.2 Related Requirements

.1 Project Drawings & Specifications Inclusive

.3 Acronyms:

.1 AFD - Alternate Forms of Delivery, service provider.
.2 O&M - Building Operations and Maintenance Manual.
.3 Cx - Commissioning.
.4 EMCS - Energy Monitoring and Control Systems.
.5 O&M - Operation and Maintenance.
.6 PI - Product Information.
.7 PV - Performance Verification.
.8 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

.1 Commissioning (Cx) is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:

.1 Verify installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.
.2 Ensure appropriate documentation is compiled into the BMM.
.3 Effectively train O&M staff.

.2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

.3 Design Criteria: Prepared by the Design Consultants to meet Project functional and operational requirements.

.4 Work shall include the implementation of coordinated commissioning activities, executed by the Contractor, and overseen by a Commissioning Process Manager reporting to the Departmental Representative.

1.3 COMMISSIONING OVERVIEW

.1 Commissioning (Cx) for this project shall include:

1. New HVAC and Controls as they relate to the Lab Upgrades.
2. New power (panelboards, branch circuits, receptacles).
3. A Building Integrated Systems Test to confirm operations under emergency conditions.

.2 For additional details on Cx responsibilities refer to Section 01 91 31- Commissioning Plan.

.3 Cx to be a line item of Contractor's cost breakdown.

.4 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.5 Cx is conducted in concert with activities performed during each stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the facility remediation is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

.6 Departmental Representative will issue Interim Acceptance Certificate when:

.1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
.2 Equipment, components and systems have been commissioned.
.3 O&M training has been completed.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

.1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative and Cx Process Manager, to ensure effective performance.

.2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

.1 Before Construction:

.1 Review Contract Documents, confirm by writing to Departmental Representative and Cx Process Manager.

.1 Adequacy of provisions for Cx.
.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:

.1 Co-ordinate provision, location and installation of provisions for Cx.

.3 Before start of Cx:

.1 Review Cx Plan and advise of issues.
.2 Ensure installation of related components, equipment, sub-systems, systems is complete.
.3 Fully understand Cx requirements and procedures.
.4 Maintain Cx documentation concurrant with construction progress.
.5 Understand completely the design criteria and intent and special features.
.6 Complete start-up documentation as per the Cx Plan and provide test reports to the Departmental Representative and Cx Process Manager.
.7 Have Cx schedules up-to-date.
.8 Ensure systems have been cleaned thoroughly.
.9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative and Cx Process Manager for review and approval.
.10 Ensure "As-Built" system schematics are available.

.4 Inform Departmental Representative and Cx Process Manager in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to the Cx Process Manager before start-up and obtain clarification.

.2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00- Submittal Procedures.

.1 Submit no later than 4 weeks after award of Contract:

.1 Name of Contractor's Cx Coordinator.
.2 Preliminary Cx schedule.

.2 Submit proposed Cx procedures to the Cx Process Manager where not specified, and obtain written approval at least 8 weeks prior to start of Cx.

.3 Provide additional documentation relating to Cx process required by the Departmental Representative and Cx Process Manager.

1.8 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: This project will use electronic Cx Forms prepaed by the Cx Process Manager and these include Installation Check Lists and Product Information (PI) forms / Performance Verification (PV) Forms for functional testing of the systems and equipment.

.2 Departmental Representative to review and approve Cx documentation.

.3 Provide completed and approved Cx documentation to Departmental Representative and Cx Process Manager.

1.9 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.06 - Construction Progress Schedule.

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

- .1 Approval of Cx reports.
- .2 Verification of reported results.
- .3 Repairs, retesting, re-commissioning, re-verification.
- .4 Training.

1.10 PROJECT MEETINGS

.1 Commissioning will be carried as a discussion point at all project meetings: Section 01 31 19 and separate Cx meetings will be conducted on an as-needed basis depending on commissioning progress.

.2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.

.3 At approximately 70 % construction completion stage and prior to equipment start-up, the Cx Process Manager will call for a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:

- .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
- .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.

.4 Thereafter Cx meetings to be held as required during equipment start-up and functional testing period.

.5 Cx Meetings will be chaired by Cx Process Manager , who will record and distribute minutes.

.6 Ensure subcontractors and relevant manufacturer representatives are present at 70% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

.1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.12 WITNESSING OF STARTING AND TESTING

.1 Provide 10 days notice prior to commencement.

.2 Departmental Representative and Cx Process Manager may witness all start-up and testing.

.3 Contractor's Cx Coordinatorto be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

.1 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Cx Process Manager.

- .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
- .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.2 Integrity of warranties:

- .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
- .2 Verify with manufacturer that testing as specified will not void warranties.

.3 Qualifications of manufacturer's personnel:

- .1 Experienced in design, installation and operation of equipment and systems.
- .2 Ability to interpret test results accurately.
- .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

.2 Conduct start-up and testing in following distinct phases:

- .1 Included in delivery and installation:
  - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
  - .2 Visual inspection of quality of installation.
- .2 Start-up: follow accepted start-up procedures.
- .3 Operational testing: document equipment performance.
- .4 System PV: include repetition of tests after correcting deficiencies.
- .5 Post-substantial performance verification: to include fine-tuning.

.3 Correct deficiencies and obtain approval from Cx Process Manager after distinct phases have been completed and before commencing next phase.

.4 Document required tests on the digital Cx forms.

.5 Failure to follow accepted start-up procedures may result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

.1 Minor equipment/systems: implement corrective measures approved by Departmental Representative and Cx Process Manager.

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative and Cx Process Manager.

.3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.

.1 Rejected equipment to be remove from site and replace with new.
.2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to Departmental Representative and Cx Process Manager for approval before commencement of commissioning.

.2 Start-up documentation to include:

.1 Factory and on-site test certificates for specified equipment.
.2 Pre-start-up inspection reports.
.3 Installation/start-up check lists.
.4 Start-up reports,
.5 Step-by-step description of complete start-up procedures, to permit facilities operators to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative and Cx Process Manager for approval before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

.1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

.2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

.1 Notify Departmental Representative and Cx Process Manager least 14 days prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS / EQUIPMENT

.1 Submit to Departmental Representative and Cx Process Manager] for review and approval:

.1 Complete list of instruments proposed to be used.
.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:

.1 2-way radios.
.2 Ladders.
.3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:

.1 Under actual operating conditions or simulated conditions (depending on outside weather conditions), over entire operating range, in all modes.
.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

.4 EMCS trending to be available as supporting documentation for performance verification.

1.21 WITNESSING COMMISSIONING

.1 Cx Process Manager shall witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

.1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.

.2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.

.3 Provide copies to Departmental Representative and Cx Process Manager within 5 days of test and with Cx report.

1.23 COMMISSIONING CONSTRAINTS

.1 As work is being completed within an operating facility, coordinate Cx Activities as necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems to avoid interfering with staff operations, before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.24 EXTRAPOLATION OF RESULTS

.1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Departmental Representative and Cx Process Manager in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

1.25 EXTENT OF VERIFICATION

.1 Laboratory areas:

- .1 Provide manpower and instrumentation to verify up to 100 % of reported results.

.2 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.

.3 Review and repeat commissioning of systems if inconsistencies found in more than 20 % of reported results.

.4 Perform additional commissioning until results are acceptable to Departmental Representative and Cx Process Manager.

1.26 REPEAT VERIFICATIONS

.1 Assume costs incurred by Departmental Representative and Cx Process Manager] for third and subsequent verifications where:

- .1 Verification of reported results fail to receive Departmental Representative and Cx Process Manager approval.
- .2 Repetition of second verification again fails to receive approval.
- .3 Departmental Representative and Cx Process Manager deems Contractor's request for second verification was premature.

1.27 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

1.28 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative and Cx Process Manager .

.2 Report problems, faults or defects affecting Cx to Departmental Representative and Cx Process Manager in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative and Cx Process Manager .

1.29 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx, leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative and Cx Process Manager.

1.30 ACTIVITIES UPON COMPLETION OF COMMISSIONING

.1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.31 TRAINING

.1 In accordance with Section 01 79 00.13 – Demonstration and Training for Building Commissioning.

1.32 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

.1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.33 OCCUPANCY

.1 Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility.

1.34 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and PV if:

   .1 Accuracy complies with these specifications.
   .2 Calibration certificates have been deposited with [Departmental Representative and Cx Process Manager.

.2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.35 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

   .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10 % of specified values.

.2 Instrument accuracy tolerances:

   .1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

   .1 Unless otherwise specified actual values to be within +/- [2] % of recorded values.

1.36 OWNER'S PERFORMANCE TESTING

.1 Performance testing of equipment or system by Departmental Representative and Cx Process Manager will not relieve Contractor from compliance with specified start-up and testing procedures.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 This Section includes the following:

- .1 Demolition and removal of selected portions of exterior building components or structural elements.
- .2 Demolition of mechanical and electrical equipment.
- .3 Demolition and removal of selected site elements.
- .4 Repair procedures for selective demolition operations.

.2 This section does not include the following:

- .1 Removal of hazardous materials or asbestos abatement.
- .2 Demolition of interior building components and finishes.

.3 Drawings contain details that suggest directions for solving some of the major demolition and removal requirements for this project; Contractor is required to develop these details further by submitting a demolition plan prepared by a professional engineer employed by the Contractor.

1.2 RELATED REQUIREMENTS

.1 Section 02 41 19.16- Selective Interiors Demolition

.2 Section 02 81 01- Hazardous Materials

.3 Section 02 82 00.01 – Asbestos Abatement – Minimum Precautions

.4 Section 02 82 00.02 – Asbestos Abatement – Intermediate Precautions

.5 Section 02 83 10 – Lead – Base Paint Abatement – Minimum Precautions

1.3 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)

- .1 ANSI A10.8 2011, Safety Requirements for Scaffolding

.2 CSA Group:

- .1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures

.3 National Research Council Canada (NRC)

- .1 National Building Code of Canada (NBC).

.4 Department of Justice Canada (Jus)

- .1 Canadian Environmental Assessment Act (CEAA), 2012
- .2 Canadian Environmental Protection Act (CEPA), 2012
  - .1 SOR/2003-2, On-Road Vehicle and Engine Emission Regulations

.2 SOR/2006-268, Regulations Amending the On-Road Vehicle and Engine Emission Regulations

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34

.4 Motor Vehicle Safety Act (MVSA), 1995

.5 Hazardous Materials Information Review Act, 1985

.5 National Fire Protection Association (NFPA)

.1 NFPA 241 13, Standard for Safeguarding Construction, Alteration, and Demolition Operations

.6 Hazardous Building Materials Assessment, May 2019

1.4 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose of them off site, unless indicated to be removed and salvaged or removed and reinstalled.

.2 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed, removed and salvaged, or removed and reinstalled.

.3 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate selective demolition work so that work of this Section adheres to aesthetic criteria established by the Drawings and specified dimensions with all elements in planes as drawn, maintaining their relationships with all other building elements.

.2 Coordination: Coordinate with Departmental Representative for the material ownership as follows:

.1 Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Departmental Representative’s property, demolished materials shall become Contractor ’s property and shall be removed from Project site.

.3 Pre Demolition Meeting: Conduct a pre demolition meeting at Project site in accordance with requirements listed in Section 01 31 19– Project Meetings to confirm extent of salvaged and demolished materials; and to review Contractor’s demolition plan prepared by a professional engineer.

1.6 ACTION AND INFORMATION SUBMITTALS

.1 Action Submittals: Provide the following submittals before starting any work of this Section:

.1 Schedule of Selective Demolition Activities: Coordinate with Section 01 32 16.16– Construction Progress Schedule - Critical Path Method (CPM), and indicate the following:

.1 Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.

.2 Coordinate with Departmental Representative 's building manager site operations, and limit the number of interruptions during regular business hours.

.3 Interruption of utility services.

.4 Coordination for shutoff, capping, and continuation of utility services.

.5 Use of elevator and stairs.

.6 Locations of temporary partitions and means of egress, [including for others affected by selective demolition operations.

.7 Coordination with Departmental Representative's continuing occupancy of portions of existing building and of Departmental Representative's partial occupancy of completed Work.

.2 Demolition Plan: Submit a plan of demolition area indicating extent of temporary facilities and supports, methods of removal and demolition prepared by a professional engineer in accordance with requirements of Authority Having Jurisdiction, and as follows:

.1 Proposed Dust Control and Noise Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Representative reserves the right to make modifications where proposed methods interfere with the Departmental Representative’s ongoing operation

.2 Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

.3 Pre demolition Photographs: Submit photographs indicating existing conditions of adjoining construction and site improvements prior to starting Work. Include finish surfaces that may be misconstrued as damage caused by selective demolition operations.

.3 Hazardous Materials

.1 Submit description of Hazardous Materials and Notification of Project with proper authorities prior to beginning of Work as required.

.2 Informational Submittals: Provide the following submittals when requested by the Consultant Representative:

.1 Qualification Data: Submit information for companies and personnel indicating their capabilities and experience to perform work of this Section including; but not limited to, lists of completed projects with project names and addresses, names and addresses of architects and owners, for work of similar complexity and extent.

1.7 QUALITY ASSURANCE

.1 Regulatory Requirements: Comply with governing environmental notification requirements and regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction and in accordance with the following:

.1 [Provincial/Territorial Workers' Compensation Boards/Commissions] [Federal Workers' Compensation Service] .

.2 [Provincial/Territorial Occupational Health and Safety Standards and Programs] [Government of Canada, Labour Program: Workplace Safety] .

.2 Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project:

.1 Conform to the Alberta Occupational Health and Safety Act and Regulations.

.2 Conform to [provincial] [federal] [territorial] Workers' Compensation Board Regulations.

.3 Conform to the [local municipal] bylaws and regulations governing this type of work.

1.8 SITE CONDITIONS

.1 Departmental Representative will occupy portions of building immediately adjacent to selective demolition area:

.1 Conduct selective demolition so that Departmental Representative's operations will not be disrupted.

.2 Provide not less than 72 hours notice to Departmental Representative of activities that will affect Departmental Representative 's operations.

.2 Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities and as follows:

.1 Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

.3 Departmental Representative assumes no responsibility for condition of areas to be selectively demolished:

.1 Conditions existing at time of Pre Bid Site Review will be maintained by Departmental Representative as far as practical.

.2 Departmental Representative will remove the following items prior to selective demolition:

.1 Hazardous materials.

.4 Hazardous Materials: Hazardous materials are present in building to be selectively demolished. A report on the presence of hazardous materials is available at the Representative's offices for review and use:

.1 Examine Hazardous Building Materials Assessment, May 2019 to become aware of locations where hazardous materials are present.

.2 Coordinate with Section 02 81 01 – Hazardous Materials, Section 02 82 00.01 – Asbestos Abatement – Minimum Precautions, Section 02 82 00.02 – Asbestos Abatement – Intermediate Precautions, and Section 02 83 10 – Lead-Base Paint Abatement – Minimum Precautions.

.3 Do not disturb hazardous materials or items suspected of containing hazardous materials.

.5 Storage or sale of removed items or materials on site will not be permitted.

.6 Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

.7 Maintain fire protection facilities in service during selective demolition operations.

Part 2 Products

2.1 MATERIALS

.1 Temporary Support Structures: Design temporary support structures required for demolition work and other structural supports necessary for the project using a qualified professional engineer registered or licensed in province of the Work.

.2 Repair Materials: Use repair materials identical to existing materials:

  .1 If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

  .2 Use materials whose installed performance equal or surpasses that of existing materials.

  .3 Comply with material and installation requirements specified in individual technical specification Sections.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that utilities have been disconnected and capped.

.2 Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

.3 Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

.4 Notify the Departmental Representative where existing mechanical, electrical, or structural elements conflict with intended function or design:

  .1 Investigate and measure the nature and extent of conflict and submit a written report to Departmental Representative.

  .2 Departmental Representative will issue additional instructions or revise drawings as required to correct conflict.

.5 Engage a professional engineer to survey condition of building when removing elements that may result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

.6 Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

.1 Coordinate existing services indicated to remain and protect them against damage during selective demolition operations in accordance with Section 01 35 16.

.2 Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.

- .1 Arrange to shut off affected utilities with utility companies.
- .2 If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
- .3 Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- .4 Cut off pipe or conduit to a minimum of 25 mm below slab, and remove concrete mound.

.3 Coordinate with Mechanical and Electrical Divisions for shutting off, disconnecting, removing, and sealing or capping utilities.

.4 Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

.1 Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.

.2 Prior to start of deconstruction work, remove contaminated or hazardous materials listed or as directed by Departmental Representative from the site and dispose of at designated disposal facilities in safe manner in accordance with TDGA and other applicable regulatory requirements and in accordance with Section 02 81 01 – Hazardous Materials.

.3 Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities:

- .1 Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Departmental Representative and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- .2 Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
- .3 Protect existing site improvements, appurtenances, and landscaping to remain.
- .4 Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

.4 Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain in accordance with Section 01 51 00, and as follows:

.1 Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

.2 Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

.3 Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

.4 Cover and protect furniture, furnishings, and equipment that have not been removed.

.5 Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities in accordance with Section 01 52 00 - Construction Facilities.

.1 Provide temporary weather tight enclosure for building exterior.

.2 Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures.

.3 Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

.6 Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise in accordance with Section 01 51 00.

.7 Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished:

.1 Strengthen or add new supports when required during progress of selective demolition.

3.4 POLLUTION CONTROLS

.1 Dust Control: Provide temporary enclosures or other suitable methods reviewed and accepted by the Departmental Representative to limit spread of dust and dirt. Comply with governing environmental protection regulations, and as limited below:

.1 Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

.2 Wet mop floors to eliminate tracking of dirt, wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.

.2 Remove and transport debris to prevent spillage on adjacent surfaces and areas.

.3 Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

.4 Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.5 SELECTIVE DEMOLITION

.1 Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

  .1 Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

  .2 Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

  .3 Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

  .4 Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame cutting operations. Maintain fire watch and portable fire suppression devices during flame cutting operations. Follow building policies for this work, which will be provided to the successful bidder.

  .5 Maintain adequate ventilation when using cutting torches.

  .6 Remove decayed, vermin infested, or otherwise dangerous or unsuitable materials and promptly dispose of off site.

  .7 Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

  .8 Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

  .9 Dispose of demolished items and materials promptly.

  .10 Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

.2 Comply with Departmental Representative’s requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

.3 Existing Items to Remain:

  .1 Protect construction indicated to remain against damage and soiling during selective demolition

  .2 Items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete

  .3 Neatly trim openings to dimensions indicated

.4 Roofing: Remove no more existing roofing than can be covered in one day by new roofing. Refer to Section Section 07 61 00 - Sheet Metal Roofing for new roofing requirements.

.5 Air Conditioning Equipment: Remove equipment without releasing refrigerants.

3.6 CLOSEOUT ACTIVITIES

.1 Patching and Repairs: Promptly repair damage to adjacent construction caused by selective demolition operations and as follows:

- .1 Patch to produce surfaces suitable for new materials where repairs to existing surfaces are required,
- .2 Completely fill holes and depressions in remaining existing masonry walls remain with an approved masonry patching material applied according to manufacturer's written recommendations.
- .3 Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

.2 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre) as follows:

- .1 Promptly dispose of demolished materials.
- .2 Do not allow demolished materials to accumulate onsite.
- .3 Do not burn demolished materials.
- .4 Provide copies of permits, waybills, etc.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 This Section includes the following:

.1 Demolition and removal of selected portions of interior building components and finishes.

.2 Repair procedures for selective demolition operations.

.2 This section does not include the following:

.1 Removal of hazardous materials or asbestos abatement.

.2 Demolition of exterior building components or structural elements.

.3 Mechanical or electrical equipment, except as required to make minor modifications to allow the work to be completed.

.3 Drawings contain details that suggest directions for solving some of the major demolition and removal requirements for this project; Contractor is required to develop these details further by submitting a demolition plan prepared by a professional engineer employed by the Contractor.

1.2 RELATED REQUIREMENTS

.1 Section 02 41 19.13- Selective Building Demolition

.2 Section 02 81 01- Hazardous Materials

.3 Section 02 82 00.01 – Asbestos Abatement – Minimum Precautions

.4 Section 02 82 00.02 – Asbestos Abatement – Intermediate Precautions

.5 Section 02 83 10 – Lead -Base Paint Abatement – Minimum Precautions

.6 Section 09 21 16 - Gypsum Board Assemblies

1.3 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)

.1 ANSI A10.8 2011, Safety Requirements for Scaffolding

.2 American Society for Testing and Materials (ASTM):

.1 ASTM C475/C475M-15, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board

.3 CSA Group (CSA)

.1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 2012

.2 Canadian Environmental Protection Act (CEPA), 2012

.1 SOR/2003-2, On-Road Vehicle and Engine Emission Regulations

.2 SOR/2006-268, Regulations Amending the On-Road Vehicle and Engine Emission Regulations

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34

.4 Motor Vehicle Safety Act (MVSA), 1995

.5 Hazardous Materials Information Review Act, 1985

.5 National Fire Protection Association (NFPA)

.1 NFPA 241 13, Standard for Safeguarding Construction, Alteration, and Demolition Operations

.6 Hazardous Building Materials Assessment, May 2019

1.4 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose of them off site, unless indicated to be removed and salvaged or removed and reinstalled.

.2 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed, removed and salvaged, or removed and reinstalled.

.3 Waste Management Coordinator (WMC): Contractor representative responsible for supervising waste management activities as well as coordinating related, required submittal and reporting requirements.

.4 Draft Construction Waste Management Plan (Draft CWM Plan): Detailed inventory of materials in building indicating estimated quantities of reuse, recycling and landfill, prepared in accordance with Section 01 74 19 - Waste Management and Disposal and as follows:

.1 Involves quantifying by volume/weight amounts of materials and wastes generated during construction, demolition, deconstruction, or renovation project.

.5 Construction Waste Management Plan (CWM Plan): Written plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19- Waste Management and Disposal.

.6 Construction Waste Management Report (CWM Report): Written report identifying actual materials that formed CWM Plan for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19- Waste Management and Disposal.

.7 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate with Departmental Representative for the material ownership as follows:

.1 Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Departmental Representative 's property, demolished materials shall become Contractor's property and shall be removed from Project site.

.2 Coordinate selective demolition work so that work of this Section adheres to aesthetic criteria established by the Drawings and specified dimensions with all elements in planes as drawn, maintaining their relationships with all other building elements.

.2 Pre Demolition Meeting: Convene pre-installation meeting [1] week prior to beginning work of this Section, with [Representative in accordance with Section 01 31 19- Project Meetings to:

.1 Confirm extent of salvaged and demolished materials

.2 Review Contractor's demolition plan

.1 Verify existing site conditions adjacent to demolition work

.2 Coordination with other construction sub trades

.3 Hold project meetings every [week] [month] .

.4 Ensure [subcontractor representatives] [project manager] [WMC] [site supervisor] [key personnel] attend.

.5 [WMC] must provide [written] [verbal] report on status of waste diversion activity at each meeting.

.6 Departmental Representative will provide written notification of change to meeting schedule established upon contract award 24 hours prior to scheduled meeting.

1.6 ACTION AND INFORMATION SUBMITTALS

.1 Action Submittals: Provide the following submittals before starting any work of this Section:

.1 Schedule of Selective Demolition Activities: Coordinate with Section 01 32 16.16– Construction Progress Schedule - Critical Path Method (CPM), and indicate the following:

.1 Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.

.2 Coordinate with Departmental Representative 's building manager ongoing site operations, and limit the number of interruptions during regular business hours.

.3 Interruption of utility services.

.4 Coordination for shutoff, capping, and continuation of utility services.

.5 Use of elevator and stairs.

.6 Locations of temporary partitions and means of egress, including for others affected by selective demolition operations.

.7 Coordination with Departmental Representative's continuing occupancy of portions of existing building and of Departmental Representative's partial occupancy of completed Work.

.2 Demolition Plan: Submit a plan of demolition area indicating extent of temporary facilities and supports, methods of removal and demolition prepared by a professional engineer in accordance with requirements of Authority Having Jurisdiction, and as follows:

.1 Proposed Dust Control and Noise Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Departmental Representative reserves the right to make modifications where proposed methods interfere with the Departmental Representative's ongoing operation

.2 Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

.3 Pre demolition Photographs: Submit photographs indicating existing conditions of adjoining construction and site improvements prior to starting Work. Include finish surfaces that may be misconstrued as damage caused by selective demolition operations.

.3 Hazardous Materials

.1 Submit description of Hazardous Materials and Notification of Project with proper authorities prior to beginning of Work as required.

.2 Informational Submittals: Provide the following submittals when requested by the Departmental Representative :

.1 Qualification Data: Submit information for companies and personnel indicating their capabilities and experience to perform work of this Section including; but not limited to, lists of completed projects with project names and addresses, names and addresses of architects and owners, for work of similar complexity and extent.

1.7 QUALITY ASSURANCE

.1 Regulatory Requirements: Perform work as follows; use most restrictive requirements where differences occur between the municipal, provincial and federal jurisdictions:

.1 Provincial and Federal Requirements: Perform work in accordance with governing environmental notification requirements and regulations of the Authority Having Jurisdiction.

.2 Municipal Requirements: Perform hauling and disposal operations in accordance with regulations of Authority Having Jurisdiction.

.2 Qualifications: Provide proof of qualifications when requested by Departmental Representative :

.1 Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project:

.1 Conform to the Alberta Occupational Health and Safety Act and Regulation.

.2 Conform to Workers' Compensation Board Regulations.

.3 Conform to City of [local municipal] bylaws and regulations governing this type of work.

1.8 SITE CONDITIONS

.1 Departmental Representative will occupy portions of building immediately adjacent to selective demolition area:

.1 Conduct selective demolition so that Departmental Representative's operations will not be disrupted.

.2 Provide not less than 72 hours notice to Departmental Representative of activities that will affect Departmental Representative's operations.

.2 Maintain access to existing means of egress, walkways, corridors, exits, and other adjacent occupied or used facilities in accordance with Section 01 35 16:

.1 Do not close or obstruct means of egress, walkways, corridors, exits, or other occupied or used facilities without written acceptance from authorities having jurisdiction.

.3 Departmental Representative assumes no responsibility for condition of areas to be selectively demolished:

.1 Conditions existing at time of Pre Bid Site Review will be maintained by Departmental Representative as far as practical.

.2 Departmental Representative will remove the following items prior to selective demolition:

.1 [Insert items to be removed by Departmental Representative].

.4 Hazardous Substances: Hazardous Substances are present in building to be selectively demolished. A report on the presence of Hazardous Substances is available at the Departmental Representative ’s offices for review and use:

.1 Examine Hazardous Building Materials Assessment, May 2019 report to become aware of locations where hazardous materials are present.

.2 Coordinate with Section 02 81 01 – Hazardous Materials, Section 02 82 00.01 – Asbestos Abatement – Minimum Precautions, Section 02 82 00.02 – Asbestos Abatement – Intermediate Precautions, and Section 02 83 10 – Lead-Base Paint Abatement – Minimum Precautions.

.3 Do not disturb Hazardous Substances or items suspected of containing Hazardous Substances.

Part 2 Products

2.1 TEMPORARY SUPPORT STRUCTURES

.1 Design temporary support structures required for demolition work and other structural supports necessary for the project using a qualified professional engineer registered or licensed in province of the Work.

2.2 DESCRIPTION

.1 This section of the Work includes, but is not necessarily limited to, the following:

.1 Demolition, removal completely from site, and disposal of all identified components, materials, equipment and debris

.2 Selective demolition to allow new walls, bulkheads, ceilings and other materials to meet existing construction as indicated

.3 All material from demolition shall be removed from site immediately with no salvage, selling, sorting or burning permitted on site

2.3 DEBRIS

.1 Make all arrangements for transport and disposal of all demolished materials from the site.

2.4 EQUIPMENT

.1 Provide all equipment required for safe and proper demolition of the building interiors indicated.

2.5 REPAIR MATERIALS

.1 Use repair materials identical to existing materials:

.1 If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

.2 Use a material whose installed performance equals or surpasses that of existing material.

.3 Comply with material and installation requirements specified in individual Specification Sections.

.2 Prefinished Sheet Steel: Prefinished sheet steel, colour to match existing radiation cabinets, bent and profiled to match existing radiation cabinets.

.3 Gypsum Board Patching Compounds: Joint compound to ASTM C475/C475M, bedding and finishing types thinned to provide skim coat consistency to patch and prepare existing gypsum board walls ready for new finishes in accordance with Section 09 21 16 – Gypsum Board Systems.

.4 Hoarding and Dust Screens: Refer to Section 01 50 00 for stud framing and gypsum board sheathing materials.

2.6 EXISTING MATERIALS

.1 Items to be retained for re use in new construction include, but are not limited to the following:

.1 [Ceiling components]

.2 [Vertical blind vanes, and curtains and tracks]

.3 Confirm with Departmental Representative any materials that appear to be in re usable condition prior to disposal.

.4 Confirm with Departmental Representative any materials scheduled for re use that are not in re usable condition prior to installation.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that utilities have been disconnected and capped.

.2 Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

.3 Notify the Representative Consultant where existing mechanical, electrical, or structural elements conflict with intended function or design:

 .1 Investigate and measure the nature and extent of conflict and submit a written report to Representative Consultant.

 .2 Representative Consultant will issue additional instructions or revise drawings as required to correct conflict.

.4 Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

.1 Coordinate existing services indicated to remain and protect them against damage during selective demolition operations.

.2 Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.

 .1 Arrange to shut off affected utilities with utility companies.

 .2 If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.

 .3 Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

 .4 Cut off pipe or conduit to a minimum of 25 mm below slab and remove concrete mound. Patch concrete using cementitious grout.

.3 Coordinate with Mechanical and Electrical Divisions for shutting off, disconnecting, removing, and sealing or capping utilities.

.4 Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

.5 Building operations cannot be interrupted at any moment. Any required shutdown will be limited to four (4) hours and will be scheduled with the Department Representative at least two (2) weeks ahead.

3.3 PREPARATION

.1 Identify and mark all equipment and materials identified to be retained by Departmental Representative or to be re used in subsequent construction. Separate and store items to be retained in an area away from area of demolition and protect from accidental disposal.

.2 Prior to start of deconstruction work, remove contaminated or hazardous materials listed or as directed by Departmental Representative from the site and dispose of at designated disposal facilities in safe manner in accordance with TDGA and other applicable regulatory requirements and in accordance with Section 02 81 01 – Hazardous Materials.

.3 Post warning signs on electrical lines and equipment that must remain energized to serve other areas during period of demolition.

.4 Confirm that all electrical and telephone service lines entering buildings are not disconnected.

.5 Do not disrupt active or energized utilities crossing the demolition site.

.6 Provide and maintain barricades, warning signs, protection for workmen and the public during the full extent of the Work. Read drawings carefully to ascertain extent of protection required.

.7 Adjust all junction boxes, receptacles and switch boxes flush with new wall construction where additional layers to existing construction are indicated.

.8 Remove permanent marker lines used or found on exposed surfaces and at surfaces indicated for subsequent finish materials. Mechanically remove permanent marker lines and associated substrates where permanent marker lines occur and patch surface. Sealing or priming over permanent marker lines is not acceptable.

3.4 CONCRETE SLAB REINFORCING

.1 Locate location of reinforcing steel in concrete slabs prior to cutting or coring using non destructive, non ionizing radio frequency locators.

.2 Core concrete slabs to avoid reinforcing steel, electrical conduit or water pipes; adjust core location and coordinate with Engineer where slab features interfere with core drilling.

.3 Notify the Engineer immediately for further instructions where coring or cutting will damage existing slab features.

3.5 SELECTIVE DEMOLITION

.1 Demolish and dismantle work in a neat and orderly manner and in strict accordance with all regulations.

.2 At end of each day's work, leave Work in safe condition so that no part is in danger of toppling or falling.

.3 Demolish in a manner to minimize dusting and to prevent migration of dust.

.4 Selling or burning of materials on the site is not permitted.

.5 Remove concrete bases by cutting and chipping, take precautions against slab cracking and degradation. Grind edges smooth, fill and make level with self levelling grout.

.6 Fill all openings in concrete block walls with concrete masonry units, coursing to match existing, prepare ready to receive new finishes to match existing.

    .1 Provide bond beams in new openings cut into existing concrete masonry unit walls.

.2 Provide finished end masonry units to patch and repair for new jamb sections in existing concrete masonry unit walls.

.7 Fill all openings in gypsum board walls with gypsum board and steel framing to match existing, skim coat to make wall smooth and even.

.8 Remove all wall coverings scheduled for demolition. Patch and repair wall surfaces with skim coat of gypsum board joint compound leaving wall surfaces smooth and even ready for new wall finishes.

.9 Patch and repair all walls, floor and ceilings damaged during demolition with material matching adjacent walls, prepare ready for new finishes.

.10 Patch and repair all radiation cabinets, mechanical equipment and electrical fixtures damaged or exposed during demolition to match adjacent finished surfaces.

3.6 PATCHING AND REPAIRING

.1 Floors and Walls:

.1 Where walls or partitions that are demolished extend from one finished area into another, patch and repair floor and wall surfaces in the new space.

.2 Provide a level and smooth surface having uniform finish colour, texture, and appearance.

.3 Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform colour and appearance.

.4 Patch with durable seams that are as invisible as possible.

.5 Provide materials and comply with installation requirements specified in other Sections of these Specifications.

.6 Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.

.7 Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

.2 Ceilings: patch, repair, or re hang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.7 PROTECTION

.1 Prevent debris from blocking drainage inlets and systems and ground draining and protect material and electrical systems and services that must remain in operation.

.2 Arrange demolition and shoring work so that interference with the use of adjoining areas by the Departmental Representative and users is minimized.

.3 Maintain safe access to and egress from occupied areas adjoining.

.4 Provide and maintain fire prevention equipment and alarms accessible during demolition.

3.8 CLEANING

.1 Develop [Construction Waste Management Plan] related to Work of this Section and in accordance with [Section 01 74 19– Waste Management and Disposal].

.2 Waste Management: Separate waste materials for recycling in accordance with Section 01 74 19- Waste Management and Disposal, and as follows:

  .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

.3 Divert excess materials from landfill to site approved Representative Consultant.

.4 Promptly as the Work progresses, and on completion, clean up and remove from the site all rubbish and surplus material. Remove rubbish resulting from demolition work daily.

.5 Maintain access to exits clean and free of obstruction during removal of debris.

.6 Keep surrounding and adjoining roads, lanes, sidewalks, municipal rights of way clean and free of dirt, soil or debris that may be a hazard to vehicles or persons.

.7 Transport material designated for alternate disposal using approved facilities in [CWM Plan] and in accordance with applicable regulations.

  .1 Written authorization from Representative Consultant is required to deviate from facilities listed in [CWM Plan] .

.8 Dispose of materials not designated for alternate disposal in accordance with applicable regulations.

  .1 Disposal facilities must be those approved of and listed in [CWM Plan] .

  .2 Written authorization from Representative Consultant is required to deviate from disposal facilities listed in [CWM Plan] .

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 02 41 19.13 - Selective Building Demolition

.2 Section 02 41 19.16 - Selective Interior Demolition

.3 Section 02 82 00.01 - Asbestos Abatement - Minimum Precautions

.4 Section 02 82 00.02 - Asbestos Abatement - Intermediate Precautions

.5 Section 02 83 10 - Lead-Based Paint Abatement - Minimum Precautions

1.2 REFERENCES

.1 Definitions:

- .1 Dangerous Goods: product, substance or organism specifically listed or meets hazard criteria established in Transportation of Dangerous Goods Regulations.
- .2 Hazardous Material: product, substance or organism used for its original purpose; and is either dangerous goods or material that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into the environment.
- .3 Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment or disposal.

.2 Reference Standards:

- .1 Canadian Environmental Protection Act (CEPA), 1999, c.33, last amended June 17, 2019.
  - .1 Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149), last amended October 21, 2016.
- .2 Department of Justice Canada
  - .1 Transportation of Dangerous Goods Act, 1992, last amended August 28, 2019.
  - .2 Transportation of Dangerous Goods Regulation (SOR/2001-286), last amendment SOR/2019-101.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .4 National Research Council Canada Institute for Research in Construction (NRC-IRC)
  - .1 National Fire Code of Canada-2015.

1.3 SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for hazardous materials and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements to Departmental Representative for each hazardous material required prior to bringing hazardous material on site.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Transport hazardous materials and wastes in accordance with Transportation of Dangerous Goods Act, Transportation of Dangerous Goods Regulations and applicable Provincial regulations.

.3 Storage and Handling Requirements:

- .1 Co-ordinate storage of hazardous materials with Departmental Representative and abide by internal requirements for labelling and storage of materials and wastes.
- .2 Store and handle hazardous materials and wastes in accordance with applicable Federal and Provincial laws, regulations, codes and guidelines.
- .3 Store and handle flammable and combustible materials in accordance with National Fire Code of Canada requirements.
- .4 Keep no more than 250 litres of flammable and combustible liquids such as gasoline, kerosene and naphtha for ready use.
  - .1 Store flammable and combustible liquids in approved safety cans bearing the Underwriters' Laboratory of Canada or Factory Mutual seal of approval.
  - .2 Storage of quantities of flammable and combustible liquids exceeding 250 litres for work purposes requires the written approval of the Departmental Representative.
- .5 Transfer of flammable and combustible liquids is prohibited within buildings.
- .6 Transfer flammable and combustible liquids away from open flames or heat-producing devices.
- .7 Solvents or cleaning agents must be non-flammable or have flash point above 38 degrees C.
- .8 Store flammable and combustible waste liquids for disposal in approved containers located in safe, ventilated area. Keep quantities to minimum.
- .9 No smoking allowed on site.
- .10 Storage requirements for quantities of hazardous materials and wastes in excess of 5 kg for solids and 5 litres for liquids:
  - .1 Store hazardous materials and wastes in closed and sealed containers.
  - .2 Label containers of hazardous materials and wastes in accordance with WHMIS.

.3 Store hazardous materials and wastes in containers compatible with that material or waste.

.4 Segregate incompatible materials and wastes.

.5 Ensure that different hazardous materials or hazardous wastes are stored in separate containers.

.6 Store hazardous materials and wastes in secure storage area with controlled access.

.7 Maintain clear egress from storage area.

.8 Store hazardous materials and wastes in location that will prevent them from spilling into environment.

.9 Have appropriate emergency spill response equipment available near storage area, including personal protective equipment as detailed in the Environmental Protection Plan reviewed and approved by Departmental Representative.

.10 Maintain inventory of hazardous materials and wastes, including product name, quantity, and date when storage began.

.11 When hazardous waste is generated on site:

  .1 Co-ordinate transportation and disposal with Departmental Representative.

  .2 Comply with applicable Federal, Provincial and Municipal laws and regulations for generators of hazardous waste.

  .3 Use licensed carrier authorized by Provincial authorities to accept subject material.

  .4 Before shipping material obtain written notice from intended hazardous waste treatment or disposal facility it will accept material and it is licensed to accept this material.

  .5 Label containers with legible, visible safety marks as prescribed by federal and Provincial regulations.

  .6 Only trained personnel handle, offer for transport, or transport dangerous goods. Certificates of training to be provided on request of Departmental Representative.

  .7 Provide photocopy of shipping documents and waste manifests to Departmental Representative.

  .8 Track receipt of completed manifest from consignee after shipping dangerous goods. Provide photocopy of completed manifest to Departmental Representative.

  .9 Report discharge, emission, or escape of hazardous materials immediately to Departmental Representative and appropriate Provincial authority. Take reasonable measures to control release. Spill Response Plan in Environmental Protection Plan to be followed.

.12 Ensure personnel have been trained in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements.

.13 Report spills or accidents immediately to Departmental Representative and authority having jurisdiction. Submit a written spill report to Departmental Representative within 24 hours of incident.

Part 2 Products

2.1 MATERIALS

.1 Description:

.1 Bring on site only the quantities of hazardous material required to perform Work.

.2 Maintain MSDS in proximity to where materials are being used where the environmental protection plan is stored. Communicate this location to personnel who may have contact with hazardous materials.

Part 3 Execution

3.1 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

.3 Waste Management: separate waste materials for recycling and disposal in accordance with Section 01 74 19 - Waste Management and Disposal.

.1 Dispose of hazardous waste materials in accordance with applicable Federal and Provincial acts, regulations and guidelines.

.2 Burning, diluting or mixing hazardous wastes for purpose of disposal is prohibited.

.3 Disposal of hazardous materials in waterways, storm or sanitary sewers or in municipal solid waste landfills is prohibited.

.4 Dispose of hazardous wastes in timely fashion in accordance with applicable Provincial regulations.

.5 Minimize generation of hazardous waste to maximum extent practicable. Take necessary precautions to avoid mixing clean and contaminated wastes.

END OF SECTION

PROFESSIONAL GEOSCIENTIST ALBERTA
P. D. KLASSEN
PDK
2020/06/25

PERMIT TO PRACTICE
EGE ENGINEERING LTD.
Signature
Date 2020/06/25
PERMIT NUMBER: P9462
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Part 1 General

1.1 SUMMARY

.1 Comply with the requirements of this Section when performing the following work:

- .1 Removing non-friable asbestos-containing materials, if the material is removed without being broken, cut, drilled, abraded, ground, sanded or vibrated.
- .2 Breaking, cutting, grinding, sanding, drilling, scraping, vibrating or abrading non-friable asbestos containing materials using non-powered hand-held tools, if the material is wetted to control the spread of dust or fibres.

.2 Asbestos abatement (minimum precautions), including:

- .1 Red/brown sealant and black mastic associated with the air handling units and associated equipment and piping, including but not limited to ducting, duct insulation, isolation valves, control valves, heating and cooling coils, humidifiers, circulation pumps and control dampeners.
- .2 Grey sealant on duct work.
- .3 Grey caulking associated with rooftop air intake vents.
- .4 Suspected asbestos containing materials within the built-up-roof (BUR) system in areas disturbed by the work.

1.2 RELATED REQUIREMENTS

.1 Section 02 41 19.13 - Selective Building Demolition

.2 Section 02 41 19.16 - Selective Interior Demolition

.3 Section 02 81 01 - Hazardous Materials

1.3 REFERENCES

- .1 Canadian Environmental Protection Act (CEPA), 1999, c.33, last amendment June 17, 2019.
- .2 Impact Assessment Act (IAA), S.C. 2019, c. 28, s. 1, last amendment August 28, 2019 (replaces Canadian Environmental Assessment Act, 2012, repealed).
- .3 Canadian Labour Code Part II - Occupational Health and Safety (R.S.C. 1985, c.L-2), last amendment March 25, 2020.
- .4 Canadian Occupational Health and Safety Regulations, SOR/86-304, last amendment June 25, 2019.
- .5 Prohibition of Asbestos and Products Containing Asbestos Regulations, SOR/2018-196, last amendment December 30, 2018.
- .6 Transportation of Dangerous Goods Act, 1992, last amendment August 28, 2019.
- .7 Transportation of Dangerous Goods Regulation, SOR/2001-286, last amendment SOR/2019-101.
- .8 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

.9 Government of Alberta, Occupational Health and Safety Code, Alberta Regulation 87/2009 with amendments up to and including Alberta Regulation 182/2019, under the Occupational Health and Safety Act.

.10 Government of Alberta, Alberta Asbestos Abatement Manual, 2019.

.11 Hazardous Building Materials Assessment, May 2019.

1.4 DEFINITIONS

.1 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.

.2 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow thorough wetting of fibres.

.3 Asbestos Containing Materials (ACMs): materials with detectable fibres (either at a quantified concentration above 1% or an unquantified concentration less than 1%), including fallen materials and settled dust.

.4 Asbestos Work Area: area where work takes place which will or may, disturb ACMs.

.5 Authorized Visitors: Departmental Representative or representatives of regulatory agencies.

.6 Competent worker: in relation to specific work, means a worker who:

.1 Is qualified because of knowledge, training and experience to perform the work.

.2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.

.3 Has knowledge of all potential or actual danger to health or safety in the work.

.7 Friable material: means material that when dry, can be crumbled, pulverized or powdered by hand pressure, or is crumbled, pulverized or powdered.

.8 Non-Friable Material: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.

.9 Occupied Area: any area of the building or work site that is outside Asbestos Work Area.

.10 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.

.11 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for work.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction.

.3 Submit Provincial and/or local requirements for Notice of Project Form.

.4 Submit proof of Contractor's Asbestos Liability Insurance.

.5 Submit to Departmental Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.

.6 Submit proof that all asbestos workers and/or supervisor have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene and work practices while working in Asbestos Work Areas, and the use, cleaning and disposal of respirators and protective clothing.

.7 Submit proof satisfactory to Departmental Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.

1.6 QUALITY ASSURANCE

.1 Regulatory Requirements: comply with Federal, Provincial, and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these specifications, more stringent requirement applies. Comply with regulations in effect at time Work is performed.

.2 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Safety Requirements: worker protection.
  - .1 Protective equipment and clothing to be worn by workers while in Asbestos Work Area include:
    - .1 Air purifying half-mask respirator with N-100, R-100 or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected and inspected after use on each shift or more often if necessary, when issued for the exclusive use of one worker or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assigned to an operation requiring the use of a respirator unless he or she is physically able to perform the operation while using the respirator.

.2 Disposable-type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing shall consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing. To include suitable footwear, and to be repaired or replaced if torn.

.2 Eating, drinking, chewing and smoking are not permitted in Asbestos Work Area.

.3 Before leaving Asbestos Work Area, the worker can decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter or by damp wiping, before removing the protective clothing or if the protective clothing will not be reused, place it in a container for dust and waste. The container to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos waste, cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before removal from the work area, and removed from the work area frequently and at regular intervals.

.4 Facilities for washing hands and face shall be provided within or close to the Asbestos Work Area.

.5 Ensure workers wash hands and face when leaving Asbestos Work Area.

.6 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse / recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Place materials defined as hazardous or toxic in designated containers.

.3 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.

.4 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial and Municipal regulations. Dispose of asbestos waste in sealed double thickness 6 mil bags or leak proof drums. Label containers with appropriate warning labels.

.5 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

1.8 EXISTING CONDITIONS

.1 Information pertaining to ACMs to be handled, removed or otherwise disturbed and disposed of during this Project is provided in the Hazardous Building Materials Assessment, May 2019.

.2 Notify Departmental Representative of friable material discovered during Work and not apparent from drawings, specifications or report pertaining to Work. Do not disturb such material pending instructions from Departmental Representative.

1.9 PERSONNEL TRAINING

.1 Before beginning Work, provide Departmental Representative satisfactory proof that every worker has had instruction and training in hazards of asbestos exposure, in personal hygiene and work practices, and in use, cleaning, and disposal of respirators and protective clothing.

.2 Instruction and training related to respirators includes, following minimum requirements:

- .1 Fitting of equipment.
- .2 Inspection and maintenance of equipment.
- .3 Disinfecting of equipment.
- .4 Limitations of equipment.

.3 Instruction and training must be provided by a competent, qualified person.

Part 2 Products

2.1 MATERIALS

.1 Drop Sheets:

- .1 Polyethylene: 0.15 mm thick.
- .2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.

.2 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in a concentration to provide thorough wetting of asbestos-containing material.

.3 Waste Containers: contain waste in two separate containers.

- .1 Inner container: 0.15 mm thick sealable polyethylene waste bag.
- .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
- .3 Labelling requirements: affix pre-printed cautionary asbestos warning in both official languages that is visible when ready for removal to disposal site.

.4 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.

.5 Tape: fibreglass - reinforced duct tape suitable for sealing polyethylene under both dry conditions and wet conditions using amended water.

Part 3 Execution

3.1 PROCEDURES

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.2 Before beginning Work, isolate Asbestos Work Area using, minimum, preprinted cautionary asbestos warning signs in both official languages that are visible at access routes to Asbestos Work Area.

- .1 Remove visible dust from surfaces in the work area where dust is likely to be disturbed during course of work.
- .2 Use HEPA vacuum or damp cloths where damp cleaning does not create a hazard and is otherwise appropriate.
- .3 Do not use compressed air to clean up or remove dust from any surface.

.3 Prevent spread of dust from Asbestos Work Area using measures appropriate to work to be done.

- .1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in Asbestos Work Area where dust and contamination cannot otherwise be safely contained. Drop sheets are not to be reused.

.4 Wet materials containing asbestos to be cut, ground, abraded, scraped, drilled or otherwise disturbed unless wetting creates hazard or causes damage.

- .1 Use garden reservoir type low - velocity fine - mist sprayer.
- .2 Perform Work to reduce dust creation to lowest levels practicable.
- .3 Work will be subject to visual inspection and air monitoring.
- .4 Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas.

.5 Frequently and at regular intervals during Work and immediately on completion of work:

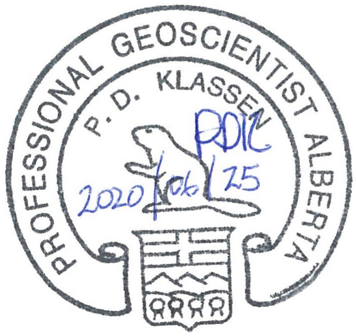
- .1 Dust and waste to be cleaned up and removed using a vacuum equipped with a HEPA filter or by damp mopping or wet sweeping, and placed in a waste container.
- .2 Drop sheets to be wetted and placed in a waste container as soon as practicable.

.6 Cleanup:

- .1 Place dust and asbestos containing waste in sealed dust-tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste; wet and fold these items to contain dust, and then place in plastic bags.
- .2 Clean exterior of each waste-filled bag using damp cloths or HEPA vacuum and place in second clean waste bag immediately prior to removal from Asbestos Work Area.
- .3 Seal waste bags and remove from site. Dispose of in accordance with requirements of Provincial and Federal Authority having jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped and that the appropriate guidelines and regulations for asbestos disposal are followed.

.4 Perform final thorough clean-up of Work areas and adjacent areas affected by Work using HEPA vacuum.

END OF SECTION



PERMIT TO PRACTICE
EGE ENGINEERING LTD.
Signature
Date 2020/06/25
PERMIT NUMBER: P9462
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Part 1 General

1.1 SUMMARY

.1 Comply with requirements of this Section when performing following Work:

- .1 Removing non-friable asbestos containing materials by breaking, cutting, drilling, abrading, grounding, sanding or vibrating if:
  - .1 The material is not wetted to control the spread of dust or fibres, and
  - .2 The work is done only by means of non-powered hand-held tools.
- .2 Removing non-friable asbestos containing materials by breaking, cutting, drilling, abrading, grounding, sanding or vibrating if the work is done by means of power tools that are attached to dust-collecting devices equipped with HEPA filters.
- .3 Removing of asbestos containing material from a pipe, duct or similar structure using a glove bag.

.2 Asbestos abatement (intermediate precautions), including:

- .1 Red/brown sealant and black mastic associated with the air handling units and associated equipment and piping, including but not limited to ducting, duct insulation, isolation valves, control valves, heating and cooling coils, humidifiers, circulation pumps and control dampeners.
- .2 Grey sealant on duct work.
- .3 Grey caulking associated with rooftop air intake vents.
- .4 Suspected asbestos containing materials within the built-up-roof (BUR) system in areas disturbed by the work.

1.2 RELATED REQUIREMENTS

.1 Section 02 41 19.13 - Selective Building Demolition

.2 Section 02 41 19.16 - Selective Interior Demolition

.3 Section 02 81 01 - Hazardous Materials

1.3 REFERENCES

.1 Canadian Environmental Protection Act (CEPA), 1999, c.33, last amendment June 17, 2019.

.2 Impact Assessment Act (IAA), S.C. 2019, c. 28, s. 1, last amendment August 28, 2019 (replaces Canadian Environmental Assessment Act, 2012, repealed).

.3 Canadian Labour Code Part II - Occupational Health and Safety (R.S.C. 1985, c.L-2), last amendment March 25, 2020.

.4 Canadian Occupational Health and Safety Regulations, SOR/86/304, last amendment June 25, 2019.

.5 Prohibition of Asbestos and Products Containing Asbestos Regulations, SOR/2018-196, last amendment December 30, 2018.

.6 Transportation of Dangerous Goods Act, 1992, last amendment August 28, 2019.

.7 Transportation of Dangerous Goods Regulation, SOR/2001-286, last amendment SOR/2019-101.

.8 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

  .1 Material Safety Data Sheets (MSDS).

.9 Government of Alberta, Occupational Health and Safety Code, Alberta Regulation 87/2009 with amendments up to and including Alberta Regulation 182/2019, under the Occupational Health and Safety Act.

.10 Government of Alberta, Alberta Asbestos Abatement Manual, 2019.

.11 Hazardous Building Materials Assessment, May 2019.

1.4 DEFINITIONS

.1 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.

.2 Asbestos Containing Materials (ACMs): materials with detectable fibres (either at a quantified concentration above 1% or an unquantified concentration less than 1%), including fallen materials and settled dust.

.3 Asbestos Work Area: area where work takes place which will or may disturb ACMs.

.4 Authorized Visitors: Departmental Representative or representatives of regulatory agencies.

.5 Competent worker: in relation to specific work, means a worker who:

  .1 Is qualified because of knowledge, training and experience to perform the work.

  .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.

  .3 Has knowledge of all potential or actual danger to health or safety in the work.

.6 Friable Materials: material that when dry can be crumbled, pulverized or powdered by hand pressure and includes such material that is crumbled, pulverized or powdered.

.7 Glove Bag: prefabricated glove bag as follows:

  .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.

  .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.

  .3 Equipped with reversible double pull double throw zipper on top and at approximately mid-section of the bag.

  .4 Straps for sealing ends around pipe.

.8 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any dimension at 99.97% efficiency.

.9 Non-Friable Material: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.

.10 Occupied Area: any area of building or work site that is outside Asbestos Work Area.

.11 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.

.12 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for scope of work.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of asbestos containing waste in accordance with requirements of authority having jurisdiction.

.3 Submit Provincial and/or local requirements for Notice of Project Form.

.4 Submit proof of Contractor's Asbestos Liability Insurance.

.5 Submit to Departmental Representative necessary permits for transportation and disposal of asbestos containing waste and proof that asbestos containing waste has been received and properly disposed.

.6 Submit proof that all asbestos workers have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene, entry and exit from Asbestos Work Area, aspects of work procedures and protective measures while working in Asbestos Work Areas, and the use, cleaning and disposal of respirators and protective clothing.

.7 Submit proof that supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by Departmental Representative. Minimum of one supervisor for every ten workers.

.8 Submit proof satisfactory to Departmental Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.

1.6 QUALITY ASSURANCE

.1 Regulatory Requirements: comply with Federal, Provincial and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at the time work is performed.

.2 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Safety Requirements: worker and visitor protection.
    - .1 Protective equipment and clothing to be worn by workers while in Asbestos Work Area include:

.1 Air purifying half-mask respirator with N-100, R-100 or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected and inspected after use on each shift, or more often if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assigned to an operation requiring the use of a respirator unless he or she is physically able to perform the operation while using the respirator.

.2 Disposable type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing to consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing. It includes suitable footwear, and it to be repaired or replaced if torn.

.3 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.

.4 Before leaving Asbestos Work Area, the worker can decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter, or by damp wiping, before removing the protective clothing, or, if the protective clothing will not be reused, place it in a container for dust and waste. The container to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos waste, cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before removal from the work area, and removed from the work area frequently and at regular intervals.

.5 Ensure workers wash hands and face when leaving Asbestos Work Area.

.6 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.

.7 Visitor Protection:

.1 Provide protective clothing and approved respirators to Authorized Visitors to work areas.

.2 Instruct Authorized Visitors in the use of protective clothing, respirators and procedures.

.3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from Asbestos Work Area.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse / recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Place materials defined as hazardous or toxic in designated containers.

.3 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.

.4 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial and Municipal regulations. Dispose of asbestos waste in sealed double thickness 6 mils bags or leak proof drums. Label containers with appropriate warning labels.

.5 Provide manifests describing and listing waste created. Transport containers by approved means to licenced landfill for burial.

1.8 EXISTING CONDITIONS

.1 Information pertaining to ACMS to be handled, removed or otherwise disturbed and disposed of during this Project is provided in the Hazardous Building Materials Assessment, May, 2019.

.2 Notify Departmental Representative of friable material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Departmental Representative.

1.9 PERSONNEL TRAINING

.1 Before beginning Work, provide Departmental Representative satisfactory proof that every worker has had instruction and training in hazards of asbestos exposure, in personal hygiene and work practices, in use of glove bag procedures, and in use, cleaning, and disposal of respirators and protective clothing.

.2 Instruction and training related to respirators includes, at minimum:

- .1 Fitting of equipment.
- .2 Inspection and maintenance of equipment.
- .3 Disinfecting of equipment.
- .4 Limitations of equipment.

.3 Instruction and training must be provided by competent, qualified person.

Part 2 Products

2.1 MATERIALS

.1 Drop and Enclosure Sheets:

- .1 Polyethylene: 0.15 mm thick.

.2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.

.2 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos containing material.

.3 Waste Containers: contain waste in two separate containers.

.1 Inner container: 0.15 mm thick sealable polyethylene bag or where glove bag method is used, glove bag itself.

.2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.

.3 Labelling requirements: affix preprinted cautionary asbestos warning, in both official languages, that is visible when ready for removal to disposal site.

.4 Glove bag:

.1 Acceptable materials: safe-T-Strip products in configuration suitable for Work, or Alternative material approved by addendum during tendering period in accordance with Instructions to Tenderers.

.2 The glove bag to be equipped with:

.1 Sleeves and gloves that are permanently sealed to the body of the bag to allow the worker to access and deal with the insulation and maintain a sealed enclosure throughout the work period.

.2 Valves or openings to allow insertion of a vacuum hose and the nozzle of a water sprayer while maintaining the seal to the pipe, duct or similar structure.

.3 A tool pouch with a drain.

.4 A seamless bottom and a means of sealing off the lower portion of the bag.

.5 A high strength double throw zipper and removable straps, if the bag is to be moved during the removal operation.

.5 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.

Part 3 Execution

3.1 SUPERVISION

.1 Minimum of one Supervisor for every ten workers is required.

.2 Approved Supervisor must remain within Asbestos Work Area during disturbance, removal, or other handling of asbestos-containing materials.

3.2 PROCEDURES

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.2 Before beginning Work, at each access to Asbestos Work Area, install warning signs in both official languages in upper case 'Helvetica Medium' letters reading as follows, where number in parentheses indicates font size to be used: 'CAUTION ASBESTOS HAZARD AREA (25 mm) / NO UNAUTHORIZED ENTRY (19 mm) / WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm) / BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM (7 mm)'.

.3 Before beginning Work remove visible dust from surfaces in work area where dust is likely to be disturbed during course of work.

  .1 Use HEPA vacuum or damp cloths where damp cleaning does not create hazard and is otherwise appropriate.

  .2 Do not use compressed air to clean up or remove dust from any surface.

.4 Prevent spread of dust from Asbestos Work Area using measures appropriate to work to be done.

  .1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in work areas where dust or contamination cannot otherwise be safely contained.

  .2 When removing asbestos containing material from piping or equipment and "glove bag" method is not used erect enclosure of polyethylene sheeting around work area, shut off mechanical ventilation system serving work area and seal ventilation ducts to and from work area.

.5 Work is subject to visual inspection and air monitoring. Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas.

.6 Cleanup:

  .1 Frequently during Work and immediately after completion of work, clean up dust and asbestos containing waste using HEPA vacuum or by damp mopping.

  .2 Place dust and asbestos containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste and wet and fold to contain dust and then place in waste bags.

  .3 Immediately before their removal from Asbestos Work Area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.

  .4 Seal and remove double bagged waste from site. Dispose of in accordance with requirements of Provincial and Federal authority having jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.

  .5 Perform final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

3.3 AIR MONITORING

.1 From beginning of Work until completion of cleaning operations, Departmental Representative to take air samples on daily basis outside of Asbestos Work Area enclosures in accordance with Provincial Occupational Health and Safety Regulations.

   .1 Contractor will be responsible for monitoring inside enclosure in accordance with applicable Provincial Occupational Health and Safety Regulations.

.2 If air monitoring shows that areas outside Asbestos Work Area enclosures are contaminated, enclose, maintain and clean these areas in same manner as that applicable to Asbestos Work Area.

.3 Ensure that respiratory safety factors are not exceeded.

.4 During the course of Work, Departmental Representative to measure fibre content of air outside Work areas by means of air samples analyzed by Phase Contrast Microscopy (PCM).

   .1 Stop Work when PCM measurements exceed 0.05 f/cc and correct procedures.

END OF SECTION

PROFESSIONAL GEOSCIENTIST ALBERTA
P. D. KLASSEN
PDK
2020/06/25

PERMIT TO PRACTICE
EGE ENGINEERING LTD.
Signature
Date 2020/06/25
PERMIT NUMBER: P9462
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Part 1 General

1.1 SUMMARY

.1 Comply with the requirements of this Section when performing the following Work:

.1 Removal of lead-containing coatings with a non or low VOC, and/or environmentally friendly chemical gel or paste and fibrous laminated cloth wrap.

.2 Removal of lead-containing coatings or materials using a power tool with an effective dust collection system equipped with a HEPA filter.

.3 Removal of lead-containing coatings or materials with non-powered hand tool, other than manual scraping and sanding.

.2 Lead base paint abatement (minimum precautions), including:

.1 Green paint on mechanical pipe insulation associated with the air handling units (13,000 mg/kg).

.2 Grey paint on concrete to be disturbed by work (2,300 mg/kg).

.3 Cream over grey paint associated with the air handling units (200 mg/kg).

1.2 RELATED REQUIREMENTS

.1 Section 02 41 19.13 - Selective Building Demolition

.2 Section 02 41 19.16 - Selective Interior Demolition

.3 Section 02 81 01 - Hazardous Materials

1.3 REFERENCES

.1 Department of Justice Canada

.1 Canadian Environmental Protection Act (CEPA), 1999, c.33, last amendment June 17, 2019.

.2 Surface Coating Materials Regulations (SOR/2016-193) under the Canada Consumer Products Safety Act.

.2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 Employment and Social Development Canada (ESDC)

.1 Canada Labour Code Part II - Occupational Health and Safety (R.S.C. 1985, c.L-2), last amendment March 25, 2020.

.4 Transport Canada (TC)

.1 Transportation of Dangerous Goods Act (TDGA), 1992, last amendment August 28, 2019.

.2 Transportation of Dangerous Goods Regulation, SOR/2001-286, last amendment SOR/2019-101.

.5 U.S. Environmental Protection Agency (EPA)

.1 EPA 747-R-95-007-1995, Sampling House Dust for Lead.

.6 U.S. Department of Health and Human Services/Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (NIOSH)

.1 NIOSH 94-113 - NIOSH Manual of Analytical Methods (NMAM), 5th Edition (February 2020).

.7 U.S. Department of Labour - Occupational Safety and Health Administration (OSHA) - Toxic and Hazardous Substances

.1 Lead in Construction Regulation - 29 CFR 1926.62-1993.

.8 U.S. Department of Housing and Urban Development (HUD), Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, Office of Healthy Homes and Lead Hazard Control, Second Edition, July 2012.

.9 Underwriters' Laboratories of Canada (ULC).

.10 Government of Alberta, Occupational Health and Safety Code, Alberta Regulation 87/2009 with amendments up to and including Alberta Regulation 182/2019, under the Occupational Health and Safety Act.

.11 Government of Alberta, Waste Control Regulation, Alberta Regulation 192/1996 with amendments up to and including Alberta Regulation 198/2019, under the Environmental Protection and Enhancement Act

.12 Work Safe Alberta – Lead at the Work Site, Occupational Health & Safety Bulletin, (2013).

.13 Hazardous Building Materials Assessment, May 2019.

1.4 DEFINITIONS

.1 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.

.2 Authorized Visitors: Owner, Departmental Representative and representatives of regulatory agencies.

.3 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects over cuts and tears, and elsewhere as required to provide protection and isolation. For protection of underlying surfaces from damage and to prevent lead dust entering in clean area.

.4 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must be appropriate capacity for scope of work.

.5 Action level: employee exposure, without regard to use of respirators, to airborne concentration of lead of 50 micrograms per cubic meter of air calculated as 8-hour time-weighted average (TWA). Minimum precautions for lead abatement are based on airborne lead concentrations less than 0.05 milligrams per cubic meter of air for removal of lead based paint by methods noted in paragraph 1.1.

.6 Competent person: individuals capable of identifying existing lead hazards in workplace taking corrective measures to eliminate them.

.7 Lead in Dust: wipe sampling on vertical and/or horizontal surfaces, dust and debris is considered to be lead contaminated if it contains more than 40 micrograms of lead in dust per square foot.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Provide proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of lead based paint waste in accordance with requirements of authority having jurisdiction.

.3 Quality Control:

- .1 Provide Departmental Representative necessary permits for transportation and disposal of lead-based paint waste and proof that it has been received and properly disposed.
- .2 Provide proof satisfactory to Departmental Representative that employees have had instruction on hazards of lead exposure, respirator use, dress, and aspects of work procedures and protective measures.

1.6 QUALITY ASSURANCE

.1 Regulatory Requirements: comply with Federal, Provincial and local requirements pertaining to lead paint, provided that in case of conflict among those requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at time work is performed.

.2 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Safety Requirements: worker and visitor protection.
  - .1 Protective equipment and clothing to be worn by workers and visitors in work Area include:
    - .1 Respirator NIOSH approved and equipped with replaceable HEPA filter cartridges with an assigned protection factor of 10, acceptable to Authority having jurisdiction. Suitable for type of lead and level of lead dust exposure. Provide sufficient amount of filters.
    - .2 Half mask respirator: half-mask particulate respirator with P - series filter, and 100% efficiency could be provided.
  - .2 Eating, drinking, chewing, and smoking are not permitted in work area.
  - .3 Ensure workers wash hands and face when leaving work area.
  - .4 Visitor Protection:
    - .1 Provide approved respirators to Authorized Visitors to work areas.
    - .2 Instruct Authorized Visitors procedures to be followed in entering and exiting work area.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse / recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

.3 Disposal of lead waste generated by removal activities must comply with Federal, Provincial and Municipal regulations. Dispose of lead waste in sealed double thickness 6 ml bags or leak proof drums. Label containers with appropriate warning labels.

.4 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

1.8 EXISTING CONDITIONS

.1 Information pertaining to lead based paint to be handled, removed or otherwise disturbed and disposed of during this Project is provided in the Hazardous Building Materials Assessment, May, 2019.

.2 Notify Departmental Representative of lead-based paint discovered during Work and not apparent from drawings, specifications or report pertaining to Work. Do not disturb such material until instructed by Departmental Representative.

1.9 SCHEDULING

.1 Not later than two days before beginning Work on this Project notify following in writing:

  .1 Appropriate Regional or Zone Director of Medical Services Branch, Health Canada.

  .2 Provincial Ministry of Labour.

  .3 Disposal Authority.

.2 Inform sub trades of presence of lead-containing materials identified in Existing Conditions.

.3 Provide Departmental Representative copy of notifications prior to start of Work.

1.10 PERSONNEL TRAINING

.1 Provide Departmental Representative satisfactory proof that every worker has had instruction and training in hazards of lead exposure, in personal hygiene, in aspects of work procedures, and in use, cleaning, and disposal of respirators.

.2 Instruction and training related to respirators includes, at minimum:

  .1 Proper fitting of equipment.

  .2 Inspection and maintenance of equipment.

  .3 Disinfecting of equipment.

  .4 Limitations of equipment.

.3 Instruction and training must be provided by competent, qualified person.

.4 Supervisory personnel to complete required training.

Part 2 Products

2.1 MATERIALS

.1 Polyethylene 0.15 mm thick unless otherwise specified; in sheet size to minimize joints.

.2 Tape: fibreglass - reinforced duct tape suitable for sealing polyethylene under dry conditions and wet conditions using amended water.

.3 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for trapping residual lead paint residue.

.4 Lead waste containers: metal type acceptable to waste disposal operator with tightly fitting covers and 0.15 mm thickness sealable polyethylene liners.

- .1 Label containers with pre-printed bilingual cautionary Warning Lead clearly visible when ready for removal to disposal site.

Part 3 Execution

3.1 SUPERVISION

.1 Approved Supervisor must remain within Lead Work Area during disturbance, removal, or other handling of lead based paints.

3.2 PREPARATION

.1 Work Area:

- .1 Install partial or full enclosures to prevent or reduce the dispersion of lead into the surrounding work area and environment, as necessary.
- .2 Shut off and isolate nearby HVAC systems to prevent dust dispersal into other building areas.
- .3 Pre-clean fixed casework, and equipment within work areas, using HEPA vacuum and cover with polyethylene sheeting sealed with tape.
- .4 Clean work area using HEPA vacuum. If not practicable, use wet cleaning method. Do not use methods that raise dust, such as dry sweeping, or vacuuming using other than HEPA vacuum.
- .5 Seal off openings with polyethylene sheeting and seal with tape.
- .6 Protect roof surfaces with polyethylene sheets or tarps.
- .7 Maintain emergency fire exits or establish alternatives satisfactory to Authority having jurisdiction.
- .8 Where water application is required for wetting lead containing materials, provide temporary water supply appropriately sized for application of water as required.
- .9 Provide electrical power and shut off for operation of powered tools and equipment. Provide 24 volt safety lighting and ground fault interrupter circuits on

power source for electrical tools, in accordance with applicable CSA Standard. Ensure safe installation of electrical cables and equipment.

.2 Do not start work until:

.1 Arrangements have been made for disposal of waste.

.2 Tools, equipment, and materials waste containers are on site.

.3 Arrangements have been made for building security.

.4 Notifications have been completed and preparatory steps have been taken.

3.3 LEAD - BASED PAINT ABATEMENT

.1 Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap; or removal equipped with HEPA filters; or removal with using power tools non-powered hand tool, other than manual scraping and sanding.

.2 Remove lead-based paint in small sections and pack as it is being removed in sealable 0.15 mm plastic bags and place in labelled containers for transport.

.3 Seal filled containers. Clean external surfaces thoroughly by wet sponging. Remove from immediate working area to Staging Area. Clean external surfaces thoroughly again by wet sponging. Wash containers thoroughly pending removal to outside. Ensure containers are removed by workers who have entered from uncontaminated areas dressed in clean coveralls.

.4 After completion of stripping work, wire brush and wet sponge surface from which lead based paint has been removed to remove visible material. During this work keep surfaces wet.

.5 After wire brushing and wet sponging to remove visible lead-based paint, and after encapsulating lead containing material impossible to remove, wet clean entire work area, and equipment used in process. After inspection by Departmental Representative apply continuous coat of slow drying sealer to surfaces of work area. Do not disturb work area for 8 hours with no entry, activity, ventilation or disturbance during this period.

3.4 INSPECTION

.1 Perform inspection to confirm compliance with specification and governing authority requirements. Deviations from these requirements not approved in writing by Departmental Representative will result in work stoppage, at no cost to Owner.

.2 Departmental Representative will inspect work for:

.1 Adherence to specific procedures and materials.

.2 Final cleanliness and completion.

.3 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

3.5 LEAD SURFACE SAMPLING - WORK AREAS

.1 Final lead surface sampling may be conducted as follows:

.1 After Work Area has passed a visual inspection for cleanliness by Departmental Representative and acceptable coat of lock-down agent has been applied to surfaces within enclosure, and appropriate setting period of 8 hours has passed, Departmental Representative may perform lead wipe sampling in Work Area.

.1 Final lead wipe sampling results from horizontal and vertical surfaces must show lead levels of less than 40 micrograms of lead in dust per square foot. Samples collected and analyzed in accordance with EPA 747-R-95-007.

.2 If wipe sampling results show levels of lead in excess of 40 micrograms per square foot, re-clean work area at contractor's expense and apply another acceptable coat of lock-down agent to surfaces and repeat as necessary until fibre levels are less than 40 micrograms per square foot.

3.6 FINAL CLEANUP

.1 Following specified cleaning procedures, and when lead wipe sampling is below acceptable concentrations proceed with final cleanup.

.2 Remove polyethylene sheet by rolling it away from walls to centre of work area. Vacuum visible lead containing particles observed during cleanup, immediately, using HEPA vacuum.

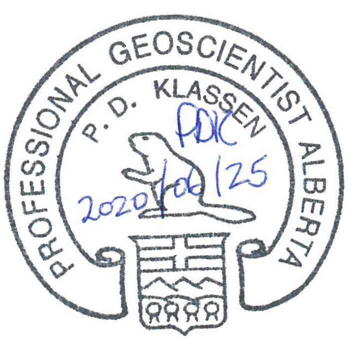
.3 Place polyethylene sheets, tape, cleaning material, clothing, and contaminated waste in plastic bags and sealed labelled waste containers for transport.

.4 Conduct final check to ensure no dust or debris remains on surfaces as result of dismantling operations.

3.7 RE-ESTABLISHMENT OF OBJECTS AND SYSTEMS

.1 Repair or replace objects damaged in course of work to their original state or better, as directed by Departmental Representative.

END OF SECTION



PERMIT TO PRACTICE
EGE ENGINEERING LTD.
Signature
Date 2020/06/25
PERMIT NUMBER: P9462
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Part 1 General

1.1 INTENT

.1 Work in Division 22 will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 22 or elsewhere, or whether defined in mechanical drawings or elsewhere.

.2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:

- .1 Water treatment
- .2 Building plumbing
- .3 Natural gas
- .4 Third party engineering fees
- .5 Electrical (if required)
- .6 C.S.A (if required)
- .7 Structural (if required)

.3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are <u>not</u> detailed installation instructions.

.4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 RELATED REQUIREMENTS

.1 Refer to and comply with the following sections:

.2	General Requirements	Division 01
.3	Submittal Procedures	Section 01 33 00
.4	Health and Safety Requirements	Section 01 35 29.06
.5	Quality Control	Section 01 45 00
.6	Temporary Utilities	Section 01 51 00
.7	Construction Facilities	Section 01 52 00
.8	Common Product Requirements	Section 01 61 00

.9	Examination and Preparation	Section 01 71 00
.10	Cleaning	Section 01 74 00
.11	Waste Management and Disposal	Section 01 74 19
.12	Closeout Procedures	Section 01 77 00
.13	Closeout Submittals	Section 01 78 00
.14	Demonstration and Training for Building Commissioning	Section 01 79 00.13
.15	General Commissioning (Cx) Requirements	Section 01 91 13
.16	Commissioning (Cx) Plan	Section 01 91 13.13
.17	Commissioning Forms	Section 01 91 13.16

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1 For complete Common Work Results requirements refer to Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

.1 For complete Common Work Results requirements refer to Section 23 05 00 – Common Work Results for HVAC.

Part 3 Execution

.1 For complete Common Work Results requirements refer to Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Floor Drains

.2 Roof Drains

.3 Cleanouts

.4 Trap Primers

.5 Water Hammer Arrestors

.6 Vacuum Breakers

.7 Backflow Preventers

1.2 RELATED REQUIREMENTS

.1	Common Work Results for Plumbing	Section 22 05 00
.2	Domestic Water Piping	Section 22 11 16
.3	Sanitary Waste and Vent Piping	Section 22 13 16

1.3 REFERENCE STANDARDS

.1 ASTM International

.1	ASTM A126-[04(2009)]	Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
.2	ASTM B62-[09]	Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA)

.1	ANSI/AWWA C700-[09]	Standard for Cold Water Meters-Displacement Type, Bronze Main Case.
.2	ANSI/AWWA C701-[12]	Standard for Cold Water Meters-Turbine Type for Customer Service.
.3	ANSI/AWWA C702-[10]	Standard for Cold Water Meters-Compound Type.

.3 CSA International

.1	CSA-B64 Series-[11]	Backflow Preventers and Vacuum Breakers.
.2	CSA B79-[08]	Commercial and Residential Drains and Cleanouts.

.4 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada 2015 (NPC).

.5 Plumbing and Drainage Institute (PDI)

.1 PDI-WH201-[R2010] Water Hammer Arresters Standard.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittals.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for plumbing specialties and accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide shop drawings for all equipment listed under Section 1.1 – Scope.

.2 All shop drawings are to clearly identify, at a minimum, the following information:

.1 Manufacturer and model

.2 Materials of construction and dimensions

.3 Electrical information (where required)

.4 Installation details

.5 All required options and accessories

1.5 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: Submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

1.6 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 FLOOR DRAINS

.1 Flow Characteristics: Full open flow unless noted otherwise. Check all construction details prior to ordering drains and ensure the drains are suitable for the construction.

.2 Refer to Plumbing Fixture Schedule on drawings for floor drain types.

2.2 ROOF DRAINS

.1 Material: All major components including body, flashing clamping flange, under deck clamp dome strainer shall be cast iron or cast aluminum, lacquered. Bolts shall be galvanized. Dome may be rigid secured plastic where specified or prior approval and shall be a natural color such as black or grey.

.2 Roof drains shall be with underdeck clamp and extension collars as required to suit roof construction. This contractor shall verify roof construction details and order roof drains accordingly at no additional cost to the contract.

.3 All drains shall be reviewed and accepted by the roofing inspector prior to ordering.

.4 Refer to Plumbing Fixture Schedule on drawings for roof drain types.

.5 Flow Characteristics: Full open flow

.6 Roof drains shall have lacquered cast iron body with large gravel sump, removable cast metal mushroom dome (or deck) strainer, flashing flange and flashing clamp with integral gravel stop, perforated extension for inverted roof.

2.3 CLEANOUTS

.1 Supply and install cleanout on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack where drains leave the building; where shown on the drawings; 7.6m (25 ft) apart in horizontal drainage lines of 50mm (2”) and 65mm (2-½”) nominal diameter; 15.2m (50 ft) apart in horizontal lines of 75mm (3”) or 100mm (4”) nominal diameter and not more than 26m (85 ft) for larger pipe sizes and as called for in the National Plumbing Code.

.2 All cleanouts shall be full size for pipes up to 100mm (4”) diameter and 100mm (4”) size of larger pipes. Cleanouts shall be extended to a finished wall or floor.

.3 Provide caulked or threaded type extended to finished floor or wall surface. Ensure ample clearance at cleanout for rodding of drainage system. The piping shall be extended beyond the room for cleanout installation. Where cleanouts occur in carpeted areas, they shall be extended to the finished walls unless the Consultant gives special permission for them to terminate in the carpeted floor.

.4 In potentially wet areas such as washrooms, cleanouts shall be extended to the walls wherever possible. Where conditions do not permit wall cleanouts, the cleanout cover shall be waterproof, with nickel bronze. frame and cover and with integral waterproofing clamping collar. All cleanouts passing through walls or floors with a waterproofing membrane shall have a clamping collar which shall be clamped to the membrane.

.5 Cleanouts for copper pipe shall be cast brass with raised shoulder on plug and gasket.

.6 Cleanouts for cast iron pipe shall be steel plug type.

.7 Covers for cleanouts shall be as follows:

  .1 Unfinished areas, such as concrete floors in equipment rooms and flush type cleanouts in outside areas:

  .2 Floor cleanout access covers in unfinished areas shall be epoxy coated cast iron body, adjustable heavy duty round nickel bronze cover suitable for heavy traffic. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

.8 All barriers for cleanout plugs shall be securely anchored so that they do not rotate when the plug is being removed.

2.4 TRAP SEAL PRIMERS

.1 Refer to Plumbing Fixture Schedule on drawings for electronic trap seal primer types.

2.5 WATER HAMMER ARRESTORS

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20mm (¾”) minimum, and minimum 450mm (18”) long.

.2 Provide stainless steel bellows or piston type water hammer arrestors on water lines connected to solenoid valves, flush valves and to fixture or group of fixtures complete with accessible isolation valve.

2.6 VACUUM BREAKERS

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards.

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions.

.3 Vacuum breakers shall meet the requirements of CSA B64 Series.

2.7 BACKFLOW PREVENTERS

.1 Construct to AWWA requirements complete with test cock as required and service repair kits.

.2 Back flow preventers shall meet the requirements of CSA B64 Series.

.3 Low Hazard: Double Check Valve Assembly:

.1 20mm to 50mm (¾" to 2"): Bronze body, celcon check seats, stainless steel trim rubber disks, bronze ball valve test cocks, bronze strainer, quarter turn bronze isolating ball valves. Reference standard CSA B.64.5.

Standard of Acceptance: Watts LF007

.2 65mm (2½") and up: Epoxy coated cast iron body, bronze seats, stainless steel trim, bronze body ball valve test cocks, epoxy coated strainer, quarter turn isolating ball valves. Reference standard CSA B.64.5. For sprinkler service, back-flow preventers to be UL/FM approved with UL/FM resilient seated OS&Y gate valves.

.4 High Hazard: Reduced Pressure Principle Type:

.1 20mm to 50mm (¾" to 2"): Bronze body, celcon check seats, stainless steel relief valve seats, shafts and flange bolts, bronze body ball valve test cocks, bronze strainer, quarter turn bronze isolating ball valves. Reference standard CSA B.64.4.

.2 65mm (2½") and up: Epoxy coated cast iron body, bronze seating and relief valve, stainless steel trim, bronze body ball valve test cocks, epoxy coated strainer, quarter turn isolating ball valves. Reference standard CSA B.64.4.

2.8 WATER METERS

.1 Each meter station and remote reader wheel required shall be to local municipality requirements using meter manifold to owner's requirements. Meters shall be required for full range of flow.

.2 Displacement type to ANSI/AWWA C700; Turbine type to ANSI/AWWA C701 and Compound type to ANSI/AWWA C702.

.3 Accessories: Remote readout device.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing specialities and accessories installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.3 INSTALLATION

.1 Install in accordance with provincial code, local bylaws and the National Plumbing Code of Canada (NPC).

.2 Install in accordance with manufacturer's instructions and as specified.

3.4 FLOOR DRAINS

.1 Where floor drains are located over occupied areas, provide waterproof installations.

.2 Coordinate type of floor drains specified with building construction details.

3.5 CLEANOUTS

.1 Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover, remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joint.

.2 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.

.3 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.4 Building drain cleanout and stack base cleanouts: line size to maximum 100mm (4”).

3.6 TRAP SEAL PRIMERS

.1 Install trap primers on all floor drains, and elsewhere as indicated. Trap primers shall be installed in an area accessible for easy maintenance.

.2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Departmental Representative.

.3 Install soft copper tubing to floor drain.

.4 All trap primers to incorporate an air gap or be provided with a reduced pressure backflow preventer.

3.7 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures and where indicated on drawings.

3.8 VACUUM BREAKERS

.1 Install approved vacuum breaker assemblies on water lines where contamination of domestic water may occur. Refer to the requirements of CSA-B64 Series – Backflow Preventers and Vacuum Breakers and where required by the authority having jurisdiction.

.2 Install vacuum breakers on any tank subject to back-siphonage.

3.9 BACKFLOW PREVENTERS

.1 Install approved backflow preventer assemblies on water lines where contamination of domestic water may occur. Refer to the requirements of CSA-B64 Series – Backflow Preventers and Vacuum Breakers and where required by the authority having jurisdiction.

.2 Install a line size double check valve assembly on water supply to: water softener and where indicated on the drawings and as required by code.

.3 The centerline of double check valve assemblies and reduced pressure backflow preventers shall be installed a minimum of 750mm (30”) and a maximum of 1500mm (60”) above the finished floor.

.4 All reduced pressure backflow preventers shall be provided with daylight type drainage or full flow piping. Pipe drain piping to the nearest indirect drain or service sink. Drain piping to terminate complete with air gap.

.5 Reduced pressure backflow preventers to be mounted in the horizontal position. Double checks can be in a horizontal or vertical position, depending on the manufacturer’s installation instructions.

.6 Test and verify all backflow preventer assemblies in accordance with CSA-B64 Series and the requirements of authorities having jurisdiction. Provide certification sheets for insertion in O & M manuals.

.7 Install check meters as indicated on drawing. Check meters are to be capable of communicating with the building management system.

3.10 START-UP

.1 General:

  .4 In accordance with Section 23 05 00 – Common Work Results for HVAC: General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:

  .1 Pressure tests have been completed.

  .2 Disinfection procedures have been completed.

  .3 Certificate of static completion has been issued.

  .4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

3.11 TESTING AND ADJUSTING

.1 General:

.1 Test and adjust plumbing specialties and accessories in accordance with Section 23 05 00 – Common Work Results for HVAC: General Requirements, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.3 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.4 Floor drains and Area drains:

.1 Verify operation of trap seal primer.

.2 Prime, using trap primer. Adjust flow rate to suit site conditions.

.3 Check operations of flushing features.

.4 Check security, accessibility, removability of strainer.

.5 Clean out baskets.

.5 Roof drains:

.1 Check location at low points in roof.

.2 Check security, removability of dome.

.3 Adjust weirs to suit actual roof slopes, meet requirements of design.

.4 Clean out sumps.

.5 Verify provisions for movement of roof systems.

.6 Vacuum breakers and backflow preventers:

.1 Test tightness, accessibility for O M of cover and of valve.

.2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.

.3 Verify visibility of discharge from open ports.

.7 Access doors:

.1 Verify size and location relative to items to be accessed.

.8 Cleanouts:

.1 Verify covers are gas-tight, secure, yet readily removable.

.9 Water hammer arrestors:

.1 Verify proper installation of correct type of water hammer arrester.

.10 Water meters:

.1 Verify location and accessibility.

.2 Test meter reading accuracy.

3.12 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.

.2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

3.13 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Domestic water piping and fittings.

.2 Domestic water valves.

.3 Domestic water piping cleaning.

.4 Domestic water piping testing.

1.2 RELATED REQUIREMENTS

.1 Common Work Results – Mechanical — Section 21 05 01

.2 Pipe Welding — Section 23 05 17

1.3 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).

- .1 ANSI/ASME B16.15 — Cast Bronze Threaded Fittings, Classes 125 and 250.
- .2 ANSI/ASME B16.18 — Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ANSI/ASME B16.22 — Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.24 — Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.

.2 ASTM International

- .1 ASTM A307 — Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B88M — Standard Specification for Seamless Copper Water Tube (Metric).
- .3 ASTM F492 — Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.

.3 American Water Works Association (AWWA).

- .1 AWWA C111 — Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Department of Justice Canada (Jus).

- .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

  .1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).

.1	MSS-SP-67-02a	Butterfly Valves.
.2	MSS-SP-70-06	Grey Iron Gate Valves, Flanged and Threaded Ends.
.3	MSS-SP-71-05	Grey Iron Swing Check Valves, Flanged and Threaded Ends.
.4	MSS-SP-80-03	Bronze Gate, Globe, Angle and Check Valves.

.7 National Research Council (NRC)/Institute for Research in Construction.

  .1 National Plumbing Code of Canada (NPC) 2015

1.4 QUALITY ASSURANCE

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 Comply with the National Plumbing Code of Canada – 2015, Provincial Codes and Municipal Codes.

.4 Non-specified pipe joining and pipe fitting methods such as T-drill and Press Fit are not permitted in any piping system covered under Division 22.

.5 Provide chemical treatment, chemicals and equipment by an agency that specializes in this type of work. This work shall be directed by the water treatment agency who, upon completion, shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

.6 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, mechanical contractor and commissioning agency.

.7 Include for the costs of an independent testing agency, selected by the Owner, to take samples of domestic water, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should the lab results prove that standards for drinking water quality have not been met, the Contractor shall correct the deficiency and cover the costs of the independent testing agency to take additional samples and tests.

.8 All equipment, service and chemicals shall be from one supplier.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittals.

.2 Shop Drawings:

.1 Valves: Submit detailed shop drawings clearly indicating, at a minimum, the following:

.1 Manufacturer

.2 Model

.3 Size

.4 Pressure rating

.5 Materials of construction

.6 Intended service

.2 Pipe Cleaning:

.1 Submit shop drawings including proposed chemicals, quantities, procedures and analysis reports to be used on this project. Provide written operating instructions and system schematics.

.2 Provide written reports containing log and procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.

.3 Submit a written report on system operations.

1.6 CLOSEOUT SUBMITTALS:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PIPE AND FITTINGS

Size	Material	Fitting	Joint
1. Domestic Water, Inside Building, Above Ground:			
All Sizes	ASTM B88 Type L, hard temper, copper tube	ANSI B16.22 capillary joint, cast brass or wrought copper	95-5 solder or brazed; cast brass - screwed

2.2 UNIONS, FLANGES, AND COUPLINGS

.1 50mm (2”) and under: 1034 kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, all bronze for copper piping. Unions to ANSI B16.3.

.2 65mm (2½) and over: 1034 kPa (150 psi) forges steel slip-on flanges for ferrous piping, 1034 kPa (150 psi) bronze flanges for copper piping with gaskets. 1.59mm thick preformed synthetic rubber, compressed ARAMID/NBR (Durlon 8500). Gaskets to be rated for temperature and pressure of system. Flanges to ASTM A181, Grade 1. For 1378 kPa (200 psi) and higher, use Class 300. For all others, use Class 150.

.3 Use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion. All couplings to be from one supplier. Mixed connections will be rejected. Use compatible gasket for pipe service.

2.3 SOLDER

.2 Solder material to ASTM B32.

.3 Use lead-free 95-5 solder for domestic water systems.

2.4 MISCELLANEOUS

.1 Use factory fabricated butt weld fittings for welded steel pipes.

.2 Use long radius elbows for steel and cast iron water piping.

2.5 DOMESTIC WATER VALVES

.1 All valves used in domestic water systems are to be lead free. Lead free is defined as material containing not more than 0.25% weighted average lead for wetted surfaces.

.2 Ball Valves

- .1 Up to 50mm (2”):

  - .1 Two-piece bronze body, full standard port, chrome plated, silicon bronze or stainless steel ball, threaded or solder ends, TFE seat and packing, level handle; Pressure Rating: 4135 kPa (600 psi) non-shock CWP; Lead- free

.3 Butterfly Valves:

- .1 50mm to 12mm (2” to 12”):

  - .1 Lug style ductile iron body, aluminum bronze alloy disc with EPDM rubber seat and seals, stainless steel stem. or grooved cast iron body,; or EPDM rubber encapsulated disc with polymer-coated body, stainless steel stem. Lever lock handle operator with multiple position lock plate on valves up to 150mm (6”), Provide gear operators on valves 200mm (8”) and larger. Pressure Rating: 1380 kPa (200 psi) non-shock CWP. Lead- free

.2 Grooved cast iron body, EPDM rubber encapsulated disc with polymer-coated body, stainless steel stem. Lever lock handle operator with multiple position lock plate on valves up to 150mm (6”), Provide gear operators on valves 200mm (8”) and larger. Pressure Rating: 1380 kPa (200 psi) non-shock CWP. Lead- free

.4 Check Valves

.1 Up to 50mm (2”):

.1 Y-pattern swing type check valve, bronze body, PTFE disc, renewable disc and seat, soldered or threaded ends. Pressure Rating: 1380 kPa (200 psi) non-shock CWP. Lead- free.

.2 Up to 50mm (2”):

.1 Inline check valve for on pump discharge.

.2 Inline lift type, bronze body, resilient PTFE disc, spring actuated, soldered or threaded ends. Pressure Rating: 1725 kPa (250 psi) non-shock CWP. Lead- free.

.3 65mm (2½”) and Over:

.1 Cast iron body silent check valve, globe style, renewable seat and disc, spring acutated, flanged or grooved ends, bronze disc and seat, flanged. Pressure Rating: Class 125, 1380 kPa (200 psi) non-shock CWP. Lead- free.

.5 Drain Valves:

.1 15mm & 20mm (½” & ¾”):

.1 Two-piece, brass ball valve, full port, PTFE seats, chrome plated brass ball, 20mm (¾”) hose end with cap and chain. Pressure Rating: 2760 kPa (400 psi) non-shock WOG. Lead- free.

.6 Gate Valves

.1 Up to 50mm (2”):

.1 Bronze body, union bonnet, rising stem, solid wedge, threaded or soldered ends. Pressure Rating: 2070 kPa (300 psi) non-shock CWP. Lead- free

.2 65mm to 300mm (2½” to 12”):

.1 Ductile iron body, bolted bonnet, non-rising stem, resilient wedge, flanged ends. Pressure Rating: 2070 kPa (300 psi) non-shock CWP. Lead- free. Meets AWWA C509 & C515 requirements.

.7 Globe Valves

.1 15mm to 50mm (½” to 2”):

.1 Bronze body and bonnet, brass disc and stem, rising stem, threaded ends. Pressure Rating: 1380 kPa (200 psi) non-shock WOG. Lead- free.

.8 Valves to be used in the hot water section of the system shall be exactly as specified in the cold water section with one exception, that all composition disc valves shall be fitted with discs suitable for hot water, rated for 2756 kPa (400 psi) at 94°C (200°F).

2.6 PIPING CLEANING MATERIALS

.1 Provide sufficient chemicals to treat domestic water systems and test the systems from the time of activation and acceptance of the building.

.2 Chemicals used must comply with environmental and health standards applicable to the usage on this project.

.3 Domestic Water System: Sodium hypochlorite conforms to ANSI/AWWA B301.

Part 3 Execution

3.1 INSTALLATION

.4 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.5 Install in accordance with National Plumbing Code 2015 and the local authority having jurisdiction.

.1 Water piping shall be complete from service connection to all fixtures, equipment, outlets, etc. Sizes of pipes shall be as shown or as specified.

.2 Exercise care in the laying of soft copper tubing that it does not bear or is in contact with rocks and that directional changes are gradual to ensure tubing will not be kinked or collapsed.

.3 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.

.4 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

.5 Install piping to allow for expansion and contraction without unduly stressing pipe or connected equipment.

.6 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.7 All copper pipe and tubing shall be free from cuts, dents or other surface damage at the time of final inspection. Remove damaged pipe or tubing and replace with new pipe or tubing.

.8 Take branches from water supply mains from the top, bottom, or side, using crossover fittings where required by structural or operating conditions.

.9 Use only eccentric reducing fittings. Top flat for water.

.10 Do not use direct welded or screwed connections to valves, equipment or other apparatus. Make all connections with an accessible mechanical connection of a style consistent with the connecting pipe joints.

.11 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.

.12 Sleeve all pipe passing through partitions, walls and floors.

.13 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.

.14 Ensure no contact between copper and ferrous metal.

.15 Provide drain valves at main shut-off valves, low points of piping and apparatus, and at the bottom of all risers.

.16 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.17 Do not run piping carrying liquids over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.18 Provide for isolation of systems by section.

.19 Use insulating plastic spacers for copper pipe installation in metal studs.

.20 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

3.2 SCREWED CONNECTIONS

.1 American National Taper pipe thread must be used for all screwed connections. Remove burrs and chips and ream or file the pipe ends out to size or bore. Not more than two (2) imperfect threads exposed when joint make-up.

.2 Make screw joints metal to metal. Do not use lampwick or other packing material in making up screwed joints.

.3 Use Teflon tape, red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

.4 Thread chromium plated piping and make up carefully. Do not expose more than one full turn of thread beyond any fitting.

3.3 WELDED CONNECTIONS

.1 Prepare mating surfaces properly; at least one mating surface shall be beveled. Longitudinally align piping carefully, set 3.2mm space between mating surfaces and tack, using 6010 rod. Preheat the materials to be joined to at least 21°C (70°F). Make a minimum of three (3) passes; use 6010 rod for root pass, use 7018 rod for subsequent filler passes and final cover pass. Remove slag and flux after each pass by brushing or grinding. Remove voids from each pass by cutting or grinding and make good by back welding.

.2 Ensure complete penetration by the root pass. Measured at the inner diameter of the piping, the weld shall be a minimum of 1mm thicker than the pipe thickness.

.3 Do not caulk or pean welds.

3.4 SOLDER AND BRAZED CONNECTIONS

.1 Remove burrs and chips and ream or file the pipe ends out to size or bore. In the case of soft copper tubing, ensure that reaming restores tubing to full diameter before jointing to fitting.

.2 Assemble joints without binding. Brazing material or solder shall penetrate fully and fill the joint completely.

3.5 ROUTE AND GRADES

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Slope water piping 0.2% and provide hose bibb drains at low points.

.3 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25mm (1”) diameter or line size whichever is greater and 150mm (6”) high minimum. Square tees may only be used to assist with complete venting and draining.

3.6 VALVE INSTALLATION

.1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.2 Align valves for easy access and identification when several service lines are installed together.

.3 Use line size throughout with the exception of control valve bypasses. Size control valve bypass valves equal to control valve.

.4 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.5 Locate valves on the main side of the unions or flanges of the equipment.

.6 Furnish extended shafts on butterfly valves when valves are to be insulated.

.7 Furnish extended shafts on butterfly valves when valves are to be insulated.

.8 Where butterfly valves are installed, provide lug type valves on flanged systems. Victaulic connections where approved.

.9 Provide drain valves at main shut-off valves, low points of piping, and equipment.

.10 Size drain lines and drain valves equal to size of equipment drain connection.

.11 For pipe sizes 20mm (¾”) and over, minimum drain size to be 20mm (¾”). Provide hose thread connection cap and chain for drain valves not piped directly to floor drains or where located in ceilings or public areas.

.12 Provide a valved drain and hose connection off the bottom of all strainers.

3.7 VALVE SCHEDULE

.1 Provide valves as indicated on drawings and the following schedule:

.1 Ball Valves:

.1 Interchangeable with gate and globe valves

.2 Branch take-offs & vertical risers (where indicated on drawings)

.2 Butterfly Valves:

.1 Interchangeable with gate valves in water systems only

.3 Drain Valves:

.1 At equipment

.2 Bases or vertical risers

.3 Low points in piping systems

.4 Near main shut-off valves

.4 Gate Valves:

.1 Branch take-offs& vertical risers (where indicated on drawings)

.2 Isolating Service -Isolate equipment and vertical risers

.3 Shut-off

3.8 PLUMBING SYSTEMS AND PIPED UTILITY TESTS

.1 Refer to Section 23 05 00 – Common Work Results for HVAC for system startup requirements.

.2 All domestic water piping shall be tested in accordance with the current National Plumbing Code of Canada 2015 and under the requirements of the Local Plumbing Inspection Branch.

.3 If approved, hydrostatic tests may be substituted with air or smoke tests when there is a danger of freezing.

.4 Test interior domestic water piping system. Completely fill and hydraulically test with a pressure of at least 1035 kPa (346 ft W.G.) at system low point, maintain the pressure for four (4) hours after all air has been expelled with all outlets tightly closed. Isolate system components not designed for this test pressure.

3.9 PIPE CLEANING

.1 General

.1 Ensure reasonable care is exercised to prevent debris, dirt and other foreign material from entering the pipe during construction. This is to include proper protection of piping on site prior to installation, temporary caps on partial systems, and complete evacuation of moisture within systems being hydrostatically pressure tested.

.2 Chemical treatment agency shall, in conjunction with the mechanical contractor, review connections for complete draining and venting of the systems. The mechanical contractor shall provide adequate drain connections to completely drain the systems within one hour.

.3 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position.

.4 Make systems completely operational, totally filled, thoroughly vented, and completely started.

.2 System Cleaning

.1 Pipes intended to carry potable water shall be disinfected before being placed in service. Disinfection procedures shall conform to AWWA C651 as hereinafter modified or expanded, and the requirements of any governing agency having jurisdiction.

.2 Flushing. Before disinfecting, the mechanical contractor shall flush all foreign matter from the pipeline. He/she shall provide hoses, pumps, temporary pipes, ditches, etc., as required to dispose of flushing water without causing damage to adjacent properties. The flushing velocities shall be at least 0.8 m/s (2.5 fps). For large diameter pipe, where it is impractical or impossible to flush the pipe at 0.8 m/s (2.5 fps) velocity, the pipeline shall be cleaned in place from the inside by brushing and sweeping, then flushing the line at a lower velocity.

.3 Disinfection Mixture. The mechanical contractor shall prepare the disinfection mixture with a chlorine-water solution having a free chlorine residual of 40 - 50 PPM. The disinfection mixture shall be prepared by injecting calcium or sodium hypochlorite and water into the piping and allowing it to flow at a measured rate so that water-chlorine solution is of the specified strength.

.4 If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a one percent solution (10,000 PPM Chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a one percent solution.

.5 Point of Application. The chlorine mixture shall be injected into the piping to be treated at the beginning of the line, and through a corporation stop or suitable tap in the top of the line. Water from the existing system or other approved sources shall be controlled so as to flow slowly into the newly installed pipe during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 40-50 PPM of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves shall be used if deemed necessary. The water treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.

.6 Retention Period. Treated water shall be retained in the pipeline long enough to destroy all non-spore forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the 24-hour period, the disinfection mixture shall have a strength of at least 25 PPM of chlorine.

.7 The above procedure shall be repeated at the mechanical contractor’s expense if the free chlorine level drops below the minimum requirements.

.8 All valves, fixtures and other appurtenances shall be operated during disinfection to ensure that the disinfection mixture is dispersed into all parts of the line, including dead ends, new services and similar areas that otherwise may not receive the treated water. The water treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.

.9 After chlorination, the water from the line shall be flushed until it meets health department requirements.

.10 Disposal of Disinfection Water. Disposal of disinfecting water shall be done in an approved manner. Disinfecting water should not be allowed to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Sanitary piping

.2 Sanitary vent piping

1.2 RELATED REQUIREMENTS

.1	Common Work Results for Plumbing	Section 22 05 00
.2	Plumbing Specialties and Accessories	Section 22 42 01

1.3 REFERENCE STANDARDS

.1 ASTM International Inc.

.1	ASTM B32-08	Standard Specification for Solder Metal.
.2	ASTM B306-02	Standard Specification for Copper Drainage Tube (DWV).
.3	ASTM C564-03a	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
.4	ASTM D2235-04	Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
.5	ASTM D2564-04e1	Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International).

.1	CSA B67-1972(R1996)	Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
.2	CAN/CSA-B70-06	Cast Iron Soil Pipe, Fittings and Means of Joining.
.3	CAN/CSA-B125.3-05	Plumbing Fittings.
.4	CAN/CSA-Series B1800-06	Thermoplastic Non-pressure Pipe Compendium - B1800 Series.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

  .1 Material Safety Data Sheets (MSDS).

.4 National Research Council Canada (NRC)

  .1 National Plumbing Code of Canada 2015 (NPC).

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 CLOSEOUT SUBMITTALS:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 DELIVERY & STORAGE

.2 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 WASTE MANAGEMENT AND DISPOSAL

.3 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PIPE AND FITTINGS

Size	Material	Fittings	Joint
1. Sanitary, Waste and Vent Piping Above Grade (Inside Building):			
65 (2½”) and smaller	ASTM B306 DWV grade hard temper copper tube	ANSI B16.29 cast brass or wrought copper	Soldered 50-50
75 (3”) and larger	CSA.B70,27580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, factory applied corrosion resistant coating inside and out	Mechanical joint, Hub & Spigot
40 (1½”) and larger	PVC DWV to CSA B181.2 and CAN/ULC S102.2	PVC DWV to CSA B181.2 and CAN/ULC S102.2 (Piping to be Plenum Rated)	PVC solvent cement
300 (12”) and smaller	316L stainless steel to ASTM 312	Stainless steel to ASTM A403	Welded

2.2 SOLDER

.1 Solder material to ASTM B32.

.2 Use tin-lead 50:50 solder for drainage and vent systems.

2.3 JOINTS

.1 Above Grade:

.1 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

.2 Hub and spigot:

.1 Caulking lead: To CSA B67.

Part 3 Execution

3.1 INSTALLATION

.1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Install in accordance with National Plumbing Code and the local authority having jurisdiction.

.3 Plumbing vents shall be located minimum 5m (16’-0”) from air intakes.

.4 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.5 Clamp cast iron water pipe at fittings with 20mm (¾”) rods and properly anchor and support.

.6 Install and support piping so that strain and weight does not bear on cast iron fittings or apparatus.

.7 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.

.8 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

.9 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.10 Provide clearance for proper installation of insulation and for access to drains and unions.

.11 Use only eccentric reducing fittings.

.12 Provide dielectric fittings in all dissimilar metal connections.

.13 Sleeve all pipe passing through partitions, walls and floors.

.14 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.15 Do not run piping carrying liquids over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.16 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

.17 Run pipes in straight lines and have a uniform grade between elevations noted. No branch drain shall have a lesser grade than that indicated for the main drain to which it is connected. Where elevations are not given, pipes shall have a uniform grade of 6.5mm per 300mm, except that where such grade on overhead pipes would reduce the headroom materially, the grade may be reduced to not less than 3.2mm per 300mm, if so directed by the consultant. All overhead pipes must be kept as close to structure as possible, unless otherwise indicated or noted.

3.2 ROUTE AND GRADES

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Grade horizontal drainage piping 2% minimum or as noted on drawings.

3.3 TESTING

.1 Test systems as per the requirements of the National Plumbing Code.

.2 Hydraulically test to verify grades and freedom from obstructions.

END OF SECTION

1 General

1.1 Scope

.1 Storm piping

1.2 Related Requirements

.1	Common Work Results – Mechanical	Section 21 05 01
.2	Plumbing Specialties and Accessories	Section 22 42 01

1.3 Reference Standards

.1 ASTM International Inc.

.1	ASTM B32-08	Standard Specification for Solder Metal.
.2	ASTM B306-02	Standard Specification for Copper Drainage Tube (DWV).
.3	ASTM C564-03a	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
.4	ASTM D2235-04	Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
.5	ASTM D2564-04e1	Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International).

.1	CSA B67-1972(R1996)	Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
.2	CAN/CSA-B70-06	Cast Iron Soil Pipe, Fittings and Means of Joining.
.3	CAN/CSA-B125.3-05	Plumbing Fittings.
.4	CAN/CSA-Series B1800-06	Thermoplastic Non-pressure Pipe Compendium - B1800 Series.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada 2015 (NPC).

1.4 Action and Informational Submittals

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 Delivery & Storage

.1 Deliver and store materials in accordance with Section 21 05 01 – Common Work Results – Mechanical.

1.7 Waste Management and Disposal

.1 Separate and dispose of waste materials in accordance with Section 21 05 01 – Common Work Results – Mechanical.

2 Products

2.1 Pipe and Fittings

Size	Material	Fittings	Joint
1. Storm Piping Above Grade (Inside Building)			
75 (3”) and larger	PVC DWV to CSA B181.2 and CAN/ULC S102.2 (Piping to be Plenum Rated)	PVC DWV to CSA B181.2 and CAN/ULC S102.2	PVC solvent cement
75 (3”) and larger	CSA B70, 27,580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, factory applied corrosion resistant coating inside and out	Mechanical joint, Hub & Spigot

2.2 Solder

.1 Solder material to ASTM B32.

.2 Use tin-lead 50:50 solder for drainage and vent systems.

2.3 Joints

.1 Above Grade:

.1 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

.2 Hub and spigot:

.1 Caulking lead: To CSA B67.

3 Execution

3.1 Installation

.1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Install in accordance with National Plumbing Code and the local authority having jurisdiction.

.3 Plumbing lines installed outside the building shall be separated by a minimum of 1m (3’ - 0”) horizontally between the outside surface of the lines. The lines are not permitted to be stacked.

.4 Install piping material specified to 1.0m (3’ - 0”) outside of building or as noted on drawings.

.5 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.6 Clamp cast iron water pipe at fittings with 20mm (¾”) rods and properly anchor and support.

.7 Install and support piping so that strain and weight does not bear on cast iron fittings or apparatus.

.8 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.

.9 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

.10 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.11 Provide clearance for proper installation of insulation and for access to drains and unions.

.12 Use only eccentric reducing fittings.

.13 Provide dielectric fittings in all dissimilar metal connections.

.14 Sleeve all pipe passing through partitions, walls and floors.

.15 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.16 Do not run piping carrying liquids over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.17 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

.18 Run pipes in straight lines and have a uniform grade between elevations noted. No branch drain shall have a lesser grade than that indicated for the main drain to which it is connected. Where elevations are not given, pipes shall have a uniform grade of 6.5mm per 300mm, except that where such grade on overhead pipes would reduce the headroom materially, the grade may be reduced to not less than 3.2mm per 300mm, if so directed by the consultant. All overhead pipes must be kept as close to structure as possible, unless otherwise indicated or noted.

3.2 Route and Grades

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Grade horizontal drainage piping 2% minimum or as noted on drawings.

3.3 Testing

.1 Test systems as per the requirements of the National Plumbing Code.

.2 Hydraulically test to verify grades and freedom from obstructions.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Carbon filter

.2 Domestic water softener

.3 Reverse osmosis system

.4 Accessories

1.2 RELATED REQUIREMENTS

.1	Domestic Water Piping	Section 22 11 16
.2	Plumbing Specialties and Accessories	Section 22 42 01
.3	Common Work Results for HVAC	Section 23 05 00

1.3 REFERENCE STANDARDS

.1 National Research Council of Canada (NRC)

- .1 National Plumbing Code of Canada 2015 (NPC)

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

- .1 Provide manufacturer's printed product literature and datasheets and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

- .1 Shop drawings shall indicate, at a minimum, the following information:
  - .1 Resin tank, salt tank and brine tank dimensions and capacities
  - .2 Carbon filter dimension and capacities
  - .3 Reverse osmosis system flow rate, micron filter size and dimensions
  - .4 Interconnecting piping, fittings and sizes
  - .5 Integral and associated controls and valves with wiring requirements
  - .6 Electrical characteristics

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 CARBON FILTER

.1 Corrosion resistant NSF certified fiberglass tank.

.2 Polypropylene lower distribution system.

.3 High surface area with a minimum of 1,050 m2/g, low carbon fines, coconut shell carbon.

.4 Control Valve:

- .1 Lead-free brass body.
- .2 Adjustable backwash and flush cycles.
- .3 LCD display with user selectable time clock or metered function.
- .4 Electrical: 120 Volt, Single Phase, 60 Hertz. System to be complete with 120V/12V approved Class 1 transformer.

2.2 REVERSE OSMOSIS SYSTEM

.1 The reverse osmosis system shall be CSA approved.

.2 System construction:

- .1 Powder coated steel frame.
- .2 NEMA rated control box
- .3 Membrane housings: 304 stainless steel
- .4 Piping: Sch. 80 PVC, brass and stainless steel
- .5 Tubing: NSF 61 high density polyethylene

.3 The system shall include:

- .1 Pump: Multi-stage centrifugal, ODP motor.

.2 Electronic controller with indicators for tank full, low pressure, pre-treatment lock out, flushing and processing.

.3 Unit on/off switch

.4 Large capacity 5-micron sediment pre-filter

.5 Inlet solenoid.

.6 Liquid filled pre-filter, post-filter and membrane pressure gauges.

.7 Product water, reject water, and recycle water flow meters.

.8 Stainless steel product water check valve.

.9 Low-pressure shut-off with auto restart.

.10 Pump throttle valve.

.11 Feed water and product water TDS monitor.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Reverse osmosis system to be installed on 100mm (4”) high concrete housekeeping pad.

.2 Manufacturer’s technical representative shall inspect the reverse osmosis system after installation is complete and shall submit a written report verifying that the installation is correct.

.3 Pipe drains to nearest indirect floor drain. Terminate drains with an air gap.

.4 System to be completely accessible for removal, modification and cleaning.

3.3 PERFORMANCE

.1 Refer to Reverse Osmosis Schedule on drawings.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 This contractor shall be responsible for and ensure that all ductwork is internally clean when handed over to the Owner. This responsibility includes the entire system, from outdoor air intakes to air terminals and from air terminal to relief outlets. It includes all ductwork, lined and unlined, all plenums and all equipment within or connected to ducts and plenums.

.2 The surfaces shall be considered clean when all foreign materials capable of particulating and visible to the naked eye are removed.

.3 The Contractor shall initiate quality control measures during the fabrication and installation of all ductwork to clean/keep clean all ductwork, so that ductwork cleaning may not be required at the completion of the work. Consultant shall review cleanliness of ductwork, and at the sole discretion and direction of the Consultant, the ductwork cleaning requirements of this section may be required, reduced or eliminated. However, if the ductwork does require cleaning, it shall be done as per the requirements of this section, and shall be at no additional cost to the Owner.

1.2 RELATED REQUIREMENTS

.1	Metal Ducts – Low Pressure to 500 kPa	Section 23 31 13.01
.2	Air Duct Accessories	Section 23 33 00
.3	Louvers, Intakes and Vents	Section 23 37 20

1.3 REFERENCE STANDARDS

.1 National Air Duct Cleaners Association (NADCA)

.1 ACR Standard, 2013 edition — Assessment, Cleaning and Restoration of HVAC Systems.

.2 North American Insulation Manufacturers Association (NAIMA)

.2 NAIMA Third Edition, 2002 — Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.

1.4 QUALITY ASSURANCE

.1 Ductwork cleaning firms shall be specialists in this field.

.2 The HVAC system cleaning sub-trade shall be a certified member of the National Air Duct Cleaners Association (NADCA) or equivalent.

.3 The Owner may hire an independent agency to review duct cleaning procedures prior to starting work and perform spot checks to confirm that duct system cleaning has been effectively executed.

1.5 DEFINITIONS

.1 Clean: No visible particulates or deposition in air systems after vacuum techniques have been completed.

.2 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:

- .1 Rigid supply, return, and exhaust ductwork;
- .2 Flexible ductwork;
- .3 Mixing plenum boxes;
- .4 Return air plenums including ceiling plenums;
- .5 Cooling and heating coils and compartments;
- .6 Condensate drain pans, eliminator blades and humidifiers;
- .7 Fans, fan blades and fan housing;
- .8 Filter housing and frames;
- .9 Acoustically insulated duct linings;
- .10 Diffusers, registers and terminal units;
- .11 Dampers and controls;

1.6 ADMINISTRATIVE REQUIREMENTS

.1 Site Evaluation: conduct site visit 2 weeks before start of work to establish specific coordinated video survey and cleaning plan to establish specific coordinated video survey and cleaning plan determining how areas of facility and HVAC systems will be protected during cleaning operations.

- .1 Organize and lay out plan for video survey and identify camera and cleaning apparatus insertion points.
- .2 Ensure plan identifies sequence and schedule of survey and cleaning operations for each individual HVAC system and for complete facility.
    - .1 Take account of elbows, bends, turning vanes, dampers, transitions, take-offs, etc.
- .3 Departmental Representative to review video survey and cleaning plan 1 week minimum prior to start of work.
    - .1 Proceed with survey and cleaning work only after receiving written approval from DCC Representative.

.2 Scheduling: Hours of Operation: complete work during non-business hours as follows:

- .1 Monday to Thursday between 18:00 hours and 07:00 hours.
- .2 Friday from 18:00 h to Monday at 07:00 h.

.3 Work may not be carried out during statutory holidays.

.4 Hours of operation are subject to change with 12 hours notice.

.3 Project Co-ordination: assign Project Coordinator to oversee air duct cleaning processes.

.1 Provide Departmental Representative with contact information of Project Coordinator including: name, telephone number, cell phone number.

.4 Security: DCC Representative will pay costs and provide security escort at times requested on Contractor's submitted work schedule.

.1 Cancellation of security escort requires 72 hours minimum written notice.

.2 Failure to cancel security escort requirements 72 hours minimum before scheduled event will result in Contractor paying for security costs.

.5 Damaged or broken equipment and components found during initial testing and inspection will be repaired or replaced by DCC Representative.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit certification of NADCA membership (or equivalent).

.3 Submit list of five (5) recent projects of similar magnitude.

.4 Submit the name of the superintendent-in-charge of the work and list his project experience.

.5 Submit an outline of the work scope for each ductwork system for review prior to starting work, including lighting strategy and procedures, cleaning procedures, equipment, materials, and schedule.

.6 Submit video survey and cleaning plan developed during site evaluation.

.1 Ensure plan includes sequence of operation, identification of camera and cleaning apparatus insertion points and schedule for work.

1.8 CLOSEOUT SUBMITTALS

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

.2 Post Cleaning Inspection Report: submit 4 copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:

.1 Name and address of facility;

.2 Name and address of HVAC cleaning contractor;

.3 Description of HVAC systems with drawings identifying systems cleaned;

.4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;

.5 Identification of points where samples were collected and type of analysis used for each collection;

.6 Identification of each sample collected;

.7 Comments complete with photographs of each sampling location and other observed system features;

.8 Identify systems tested, observations, actions taken and recommendations for future maintenance.

.3 Record post cleaning video survey: submit 2 copies of video survey on DVD media, and include on video survey following:

.1 Areas tested for particulate analysis or microbial growth evaluation;

.2 Areas of special interest and location;

.3 Special internal features;

.4 Problems such as broken or damaged controls or components;

.5 Ensure system tested, locations, observations, actions taken and recommendations are clearly identified in English on video using text or voice over.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 APPROVED AGENCIES

.1 Contractor to submit proposed agency for Consultant and Owner approval.

2.2 ACCESS DOORS AND PANELS

.1 Equipment Access Doors and Panels: Construct from same materials as equipment paneling complete with sealing gasket and positive locking device.

.1 Size access doors and panels in equipment to allow for inspection and cleaning.

.2 Ductwork Access Doors: Construct access doors from the same gage and material as the ductwork with gasketted seal.

.1 Ensure access door is 25mm (1”) greater in every dimension than access opening.

.2 Access door size 200mm x 200mm (8”x8”) minimum.

.3 Secure access doors with sheet metal screws on 75mm (3”) centers minimum. Ensure 3 screws per side minimum.

.3 Access Doors and Panels Acoustic Lining:

.1 Install acoustic lining to match existing.

.2 Self-adhesive glass fibre tape capable of adhering to both acoustic lining and metal access door or panel materials.

.3 Water-based duct sealer for repairing cut acoustic lining.

2.3 SYSTEM FILTERS

.1 Supply and install new filters for each HVAC System cleaned.

2.4 AIR DUCT CLEANING EQUIPMENT

.1 Manually propelled full contact brushes:

.1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.

.1 Ensure brushes are sized to fit various duct sizes in HVAC system.

.2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.

.2 Brushes: manually propelled with integrally-mounted motor or drive] and nylon or other non-metallic material bristles.

.1 Replace worn and ineffective brushes when required.

Part 3 Execution

3.1 PREPARATION

.1 Close down HVAC system.

.2 Locate and identify externally visible HVAC system features which may affect cleaning process including, but not limited to:

.1 Control devices;

.2 Fire and smoke control dampers;

.3 Balancing dampers: indicate and record positions for resetting;

.4 Air volume control boxes: indicate and record positions for resetting;

.5 Fire alarm devices;

.6 Monitoring devices and controls;

.3 Cut openings in equipment panels and ductwork for access to system interior.

.1 Square or rectangular opening sizes: 200mm (8”) minimum each side.

.2 Circular opening sizes: 200mm (8”) minimum diameter.

.4 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibreglass tape and water based duct sealer.

.1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.

.5 Remove and reinstall ceiling panels or tiles to gain access to HVAC system as required.

.1 Replace ceiling panels or tiles damaged or soiled by air duct cleaning procedures.

3.2 INSTALLING ACCESS DOORS

.1 Provide and locate access doors and install as follows:

.1 At 12.0m (36 ft) intervals in vertical ducts.

.2 Horizontal ducts at intervals of 6m (18 ft).

.3 At the base of all duct risers.

.4 Both sides of turning vanes in all ducts.

.5 At each fire damper location.

.6 At each side of all coils except where an access is provided.

.7 At all locations of internally duct mounted equipment or devices including balancing dampers, automatic dampers, damper motors, duct mounted smoke detectors and heat detectors, and controls, except where access is provided.

.8 Where required to facilitate duct cleaning.

3.3 EXAMINATION / PRE-CLEANING INSPECTION

.1 Verification of Conditions:

.1 The Cleaning Agency shall perform a full visual inspection of the interior of HVAC systems to evaluate condition and cleanliness of HVAC systems and components.

.2 Utilize a fiber optic borescope with dedicated light source, inspect interior ductwork surfaces, ductwork accessories, and component.

.2 Evaluation and Assessment:

.1 Identify location and type of internal components.

.2 Identify extent of potential problems.

3.4 CLEANING

.1 Complete duct cleaning in accordance with NADCA ACR Standard.

.2 On completion of the duct and plenum installation and prior to the installation of air terminals and prior to balancing of the air systems, but not until the areas are substantially clean (floors have been swept and vacuumed) and all "dirty" construction has been completed, employ an approved Cleaning Agency to vacuum clean the following:

- .1 All air handling units.
- .2 All plenums.
- .3 All supply and return air ducts.
- .4 All exhaust air ducts.

.3 All components within each system shall be thoroughly cleaned and shall include but not be limited to the following: coils, fans and motors, silencers, air terminals and mixing boxes / air terminal boxes.

.4 When connecting to existing supply ductwork, clean existing supply ducts upstream from connection back to the filters. Clean existing supply ductwork downstream from new connections to outlets.

.5 Cleaning shall generally be by high capacity power vacuum. High-pressure compressed air, wire brushing and/or non-toxic solvent cleaning shall be used where dirt or scale cannot be removed otherwise.

.6 Coils shall be de-scaled.

.7 Install temporary filters as follows:

- .1 Behind all grilles and diffusers.
- .2 In front of all duct coils.
- .3 At inlet of all terminal high velocity units to protect pitot openings.

.8 The Cleaning Contractor shall be responsible for removing and replacing filter media. This contractor will remove the temporary filters and replace with new after cleaning the systems.

.9 The Cleaning Contractor shall mark balancing damper positions before cleaning and return them to their original position when cleaning is completed unless the system is still to be balanced.

.10 Reinstall any grilles, registers and diffusers, which may have been removed for cleaning purposes.

.11 Remove perforated supply diffusers from suspended tee-bar ceiling.

- .1 Dismantle and clean perforated plates and supply diffuser duct collars.

.2 Re-assemble perforated plate diffusers and reconnect to HVAC system using supply diffuser duct collar after cleaning.

.12 After duct systems have been cleaned, they shall be resealed if they are not being used. Provide filter media on the return air terminals, in a ducted return system, if the return air fans are run after cleaning has been completed. Where the ceiling is being used as a return air plenum, provide filter media on the return air opening at the shaft.

.13 Ducts serving very clean areas served with 85% NBS or HEPA filters shall be reviewed by the Consultant utilizing the equivalent of a white glove wipe technique.

3.5 ACOUSTICALLY LINED DUCTWORK CLEANING

.1 Clean glass fiber acoustically insulated ducts to NAIMA recommended practices.

3.6 COMPONENTS AND EQUIPMENT CLEANING

.1 Brush and vacuum coils, humidifiers, air handling unit enclosures.

.2 When cleaning equipment and components by brushing and vacuuming is inappropriate or insufficient, dismantle and remove equipment or component and move to area designated by Departmental Representative for cleaning.

.1 Pressure wash with water and cleaning solution until required cleanliness is achieved.

.2 Clean equipment and components in place only if there is no hazard to adjacent materials.

.3 Fan blades;

.4 Dampers;

.5 Turning vanes;

.6 Controls;

.7 Sensor bulbs;

.8 Fire alarms;

.9 Smoke detectors;

3.7 FIELD QUALITY CONTROL/FINAL INSPECTIONS

.1 Spot checks will be made by the Consultant during the cleaning process to verify that the required standard is being met. If any ducts are found to be unclean, then they shall be recleaned.

.2 When substantial performance is claimed, final spot checks will be made to verify that the ducts are clean. Make available for the use of the Consultant a fiber optic borescope with dedicated light source. If any ducts are found to be unclean, then they shall be recleaned.

.3 Post Cleaning Inspection: Carry out final inspection using visual inspection methods after final cleaning has been completed.

 .1 Carry out video survey as directed by Departmental Representative.

 .2 Include in final survey areas inspected by Departmental Representative prior to cleaning.

 .3 Identify on HVAC system record drawings access points used for inspection and cleaning.

 .4 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

.4 Submit a report from the Cleaning Agency that certifies all specified air systems have been cleaned.

3.8 SYSTEM STARTUP

.1 Install new system filters after cleaning operations are completed.

.2 Cover each inspection opening with access door or panel and secure in place after inspection and cleaning are completed.

.3 Restart each HVAC system.

END OF SECTION

Part 1 General

1.1 INTENT

.1 Work in Division 23 will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 23 or elsewhere, or whether defined in mechanical drawings or elsewhere.

.2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:

- .1 Ventilation
- .2 Boilers
- .3 Water treatment
- .4 Building HVAC
- .5 Third party engineering fees
- .6 Electrical (if required)
- .7 C.S.A (if required)
- .8 Structural (if required)

.3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are <u>not</u> detailed installation instructions.

.4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 RELATED REQUIREMENTS

.1 Refer to and comply with the following sections:

.1	General Requirements	Division 01
.2	Submittal Procedures	Section 01 33 00
.3	Health and Safety Requirements	Section 01 35 29.06
.4	Quality Control	Section 01 45 00
.5	Temporary Utilities	Section 01 51 00
.6	Construction Facilities	Section 01 52 00
.7	Common Product Requirements	Section 01 61 00
.8	Examination and Preparation	Section 01 71 00

.9	Cleaning	Section 01 74 00
.10	Waste Management and Disposal	Section 01 74 19
.11	Closeout Procedures	Section 01 77 00
.12	Closeout Submittals	Section 01 78 00
.13	Demonstration and Training for Building Commissioning	Section 01 79 00.13
.14	General Commissioning (Cx) Requirements	Section 01 91 13
.15	Commissioning (Cx) Plan	Section 01 91 13.13
.16	Commissioning Forms	Section 01 91 13.16

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1	Bidding Requirements and General Conditions of Contract	Division 00 and Division 01
.2	Electric Motor Power Characteristics	Division 26

1.4 REFERENCE STANDARDS

.1 National Research Council (NRC)

.1 National Building Code of Canada – Alberta Edition (NBC(AE)) 2019, as amended by local bylaws and Provincial Statutes

.2 National Fire Code of Canada – Alberta Edition (NFC(AE)) 2019, as amended by local bylaws and Provincial Statutes

.3 National Plumbing Code of Canada (NPC) 2015

1.5 CODES, REGULATIONS, PERMITS, FEES AND INSPECTIONS

.1 Conform to the latest edition and supplements of the following for all materials and installations:

.1 Codes, Standards, Bylaws, Statutes and Manufacturer's Association Specifications or instructions mentioned in Division 22 and 23 sections, refer to latest revisions thereof at time of calling of bids, unless specifically designated otherwise.

.2 In no instance shall the standard established by the drawings and specifications be reduced by code or otherwise.

.3 Where conflict or discrepancies between Codes, Standards, Bylaws, Statutes, Specifications, Drawings, etc., exist, the most stringent requirement shall apply.

.4 Furnish all notices, obtain all necessary permits related to Division 22 and 23 work.

1.6 INSTALLATION REQUIREMENTS

.1 Provide labor, material and tools required to install, test and place into operation, a complete mechanical system. Provide additional material for modifications required to correct minor job confliction.

.2 Install material and equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment as determined by the Engineer. Field verify all dimensions, clearances, maintenance clearances, equipment handing requirements, invert elevations, and other similar measurements prior to any fabrication and installation. Notify the Consultant of any discrepancies that require resolution.

.3 Confirm invert elevations and locations of connection to utilities before any excavation work is started.

.4 Install piping and ductwork only in concealed spaces, unless otherwise approved.

.5 Remove and replace improperly installed mechanical work, or work that requires modifications due to coordination issues or conflicts.

.6 Review architectural drawings and confirm that plumbing fixtures defined on Architectural Drawings are consistent with plumbing fixtures defined on mechanical drawings. Mechanical work shall include supply and installation for all fixtures defined in the contract documents.

.7 Refer to Architectural Drawings and Structural Drawings for sections, details, dimensions and information such as fire separations, expansion joints, roof construction, wall construction that has impact on the mechanical installation.

.8 Examine contract documents prepared by all disciplines and confirm that work can be installed as defined. No allowance will be made for changes unless the consultant has been notified in writing prior to tender close.

.9 Follow manufacturer’s recommended installation details and procedures for equipment, supplemented by details given herein and on plans subject to approval of the consultant.

.10 Locate distribution systems, access doors, equipment and materials for maximum usable space to satisfaction of consultant.

.11 Install equipment in a manner to facilitate maintenance and ease of repair or replacement. Provide for adequate access and sufficient clearances.

.12 Equipment used shall not exceed space limitations in any dimension. Replace any equipment or apparatus which does not meet this Specification at no cost. Assume full responsibility for the expense of redesign and adjustment to other parts of the building when proposing the use of acceptable equal or alternate equipment. It is the contractor’s responsibility to confirm all quantities. Dimensions, performance and accessories required for all equipment, including matching “standard” and operational accessories between “equal” and “acceptable” products/suppliers/manufacturers.

.13 Prepare dimensioned drawings showing sleeving, recesses, furring and openings to coordinate mechanical work with other trades.

.14 Prepare dimensioned drawings for congested areas such as mechanical rooms, shafts, corridors and spaces that require special attention to complete the installation.

1.7 PROVISIONS FOR MAINTENANCE

.1 Install piping in racks with clearance in between pipes equal to the pipe diameter. Where piping is stacked, provide a minimum 300mm (12”) clearance in between stacks.

.2 Install maintainable components such as valves, motors, traps, air vents, dampers, filters, and coils in a manner to facilitate proper access for maintenance.

.3 Install major equipment components such as pumps at floor level unless indicated otherwise. Install piping connections with isolating valves located to allow component removal with minimal system drainage.

.4 Locate flanges/unions to allow equipment removal without interruption to piping work.

.5 Allow adequate space for removal of equipment and components from the mechanical room space.

.6 Install “Pete’s Plugs” gauges and metering equipment in readily accessible and visual locations.

.7 Provide extensions to grease cups, lubrication fittings for bearings, etc. to outside of fan cabinets.

.8 Provide maintenance platforms, ladders, safety rails to Occupational Health and Safety Standards to accommodate equipment and components not easily accessed from the floor.

.9 Provide lifting lugs attached to the building structure above motors and equipment that weight in excess of 50 kg (110 lb).

.10 Allow minimum clearance in front of electrical components, such as motor control centers, starters, VFDs, control panels in accordance with applicable codes.

1.8 WARRANTY

.1 Comply with warranty requirements defined in Division 01.

.2 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of substantial performance of work. The Contractor shall repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing the operating and maintenance instructions have been complied with. The period of guarantee specified shall not, in any way, supplant any other guarantees of a longer period provided by Manufacturers or as called for in the project documents.

1.9 OWNER REQUIREMENTS DURING WARRANTY

.1 Unless specified otherwise the Owner shall be responsible for all routine maintenance requirements as required in the manufacturer’s instructions.

.2 The Owner shall be responsible for supplying replaceable components such as filters and belts during the warranty period.

1.10 MATERIALS

.1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or manufacturer and model for each specific application.

.2 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.

.3 Provide statically and dynamically balanced rotating equipment for minimum vibration and low operating noise levels. Provide balancing certificates if requested by the consultant.

.4 Replace materials or workmanship below specified quality and relocate work wrongly placed to satisfaction of the Engineer and at no cost to the Owner.

.5 Install materials and equipment in a quality manner providing good workmanship by competent tradesmen. At the request of the consultant, provide certificates proving competency of specialists employed. Certificates shall be from recognized, related governing associations. The owner and his representatives reserve the right to terminate any specific person’s employment on this project for failure to prove adequate qualifications and/or workmanship.

.6 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert the specified product and manufacturer for this project.

1.11 AVAILABILITY OF EQUIPMENT AND MATERIALS

.1 Make known in writing to the Engineer ten (10) days prior to the tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.

.2 If requested after contract award, provide within 24 hours a list of equipment and manufacturers to be used on this project. This list shall not be deviated from unless delivery, performance, or dimension issues require a change to be reviewed by the Consultant.

1.12 ALTERNATE MATERIALS AND EQUIPMENT

.1 Comply with the requirements of Division 01.

.2 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the acceptable equivalent manufacturers listed in each section.

.3 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted in duplicate, to the Engineer no later than ten (10) working days prior to the closing date of tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum and consistent with all requirements defined in Division 01.

.4 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Engineer. In the event that the product has been approved as an "Alternate Only", this shall be stated in the quotation and the difference from the base bid price indicated.

.5 Approved equivalents and/or alternatives to specified products shall be equal in performance and materials to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined. Equipment which is not equal will be replaced with the specified equipment at no cost to the Owner.

.6 The Contractor shall be fully responsible for all costs for work or materials required by the trades or other contractors to accommodate use of other than specified materials or equipment.

.7 Manufacturers/suppliers which are noted in individual sections as “Acceptable Manufacturers” are automatically approved for bidding and are not required to follow the approval process. All other manufacturers/suppliers must follow the approval process. “Approved Manufacturers” must meet all requirements of specified equipment.

1.13 METRIC CONVERSION

.1 All units in this division are expressed in SI units. Soft metric conversions are used throughout.

.2 Submit all shop drawings and maintenance manuals in SI units.

.3 On all submittals use the same SI units as stated in the specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial

.1 Where pipes are specified with metric dimensions and only Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are available and are provided, the contractor shall provide adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

.3 Record accurately on "as-built" drawings the type of pipe (i.e., Metric or Imperial) installed.

Equivalent Nominal Diameters of Pipes

mm	inches	mm	inches	mm	inches
3	1/8	50	2	300	12
6	1/4	65	2-1/2	375	15
10	3/8	75	3	450	18
15	1/2	100	4	500	20
20	3/4	125	5	600	24
25	1	150	6	750	30
30	1-1/4	200	8		
40	1-1/2	250	10		

.5 Metric Duct Sizes

.1 The metric duct sizes are expressed as 25mm = 1inch.

1.14 DRAWINGS AND SPECIFICATIONS

.1 Refer to architectural drawings for building dimensional data and construction details.

.2 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both. Any item omitted from one but which is mentioned or reasonably implied in the other shall be considered as properly and sufficiently specified.

.3 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Engineer in writing or by Addendum, before submitting tender. If this is not done, it will be assumed that the most expensive alternate has been included.

.4 Where errors or discrepancies appear in catalogue numbers, provide the material in accordance with the system requirements and to the standard of the specifications.

.5 Prior to construction start, examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work can be satisfactorily carried out without changes to building.

.6 The scope of work in this division shall include all work defined in the Contract Documents, including work which may exceed the minimum requirements of codes and standards that are referenced in the Contract Documents.

1.15 EXAMINATION OF SITE

.1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. Report discrepancies to the Engineer seven (7) days prior to tender closing. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing, thereon, which are visible or known to exist at the time of tender. Failure to advise Engineer of discrepancies will assume contractor accepts documents as presented without potential of additional costs.

1.16 EQUIPMENT DELIVERY, STORAGE AND CLEANUP

.1 Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.

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

.3 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.4 Arrange, and coordinate, storage space with the General Contractor. Materials and equipment shall be stored in a safe, dry location and shall be protected against weather, damage and theft.

.5 Protect equipment with polyethylene covers and crates.

.6 Operate, drain and flush out bearings and refill with new change of oil, before final acceptance.

.7 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.8 Replace defective or damaged materials with new.

.9 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.10 Ensure that existing equipment to be turned over to the Owner or reused is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

.11 Existing equipment that is to remain in place, and be reused, is to be protected from physical damage including freezing.

1.17 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials as specified in accordance with Section 01 74 19 – Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal corrugated cardboard, plastic, polystyrene, paper packaging material for recycling in accordance with Waste Management Plan.

.4 Where required by the Waste Management Plan, divert unused materials, including metals, from landfill to recycling facilities.

.5 Unused materials, including paint and sealants, must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.6 Fold up plastic and metal banding, flatten and place in designated area for recycling or disposal.

1.18 COORDINATION OF WORK

.1 Cooperate and coordinate with other trades on the project. Phase work in sequence with the General Contractor.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Provide coordination drawings showing the work of all trades and contractors involved, in areas of potential conflict or congestion, as requested by Engineer at no additional cost.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings.

.5 Prepare and submit drawings showing sleeving, recesses, and formed work in concrete.

.6 Prepare and submit drawings for all shafts, duct openings, roof openings and similar requirements.

.7 Coordinate with the General Contractor and Electrical Trade all requirements for electrical services to mechanical components and equipment. Motor voltages will be defined in Division 26.

.8 Using shop drawing data, prepare a comprehensive list to define all specific electrical requirements needed by the Division 22 and 23 work to complete the installation. Coordinate with Electrical Trade.

.9 Prepare and submit drawings to the General Contractor and Structural Consultant defining mechanical system support loads and support details. Include definition of pipe and/or loads on structural elements and anchor arrangements.

1.19 COORDINATION WITH DIVISION 26 (ELECTRICAL) WORK

.1 Provide motors or mechanical equipment with voltage and phase characteristics as defined in Division 26.

.2 Comply with the requirements in Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

.3 Prior to ordering any motor driven mechanical equipment, meet with the electrical trade and confirm all electrical interface requirements with mechanical components.

.4 Division 22 and 23 (Mechanical) Trade shall:

.1 Submit a list of all motor specifications and electrical connections to mechanical equipment, outlets, components, panels and point source requirements. Maintain list up-to-date and make available for site review.

.2 Include final motor list in O&M Manuals.

.3 Supply and install all low voltage (24 V) control devices, temperature control systems including direct digital central systems defined in Division 25 – Integrated Automation.

.4 Supply and set in place all variable frequency drives that are defined in Section 23 05 14 – Variable Frequency Drives for HVAC Equipment, including start-up and commission.

.5 Supply and install 110 V wiring interface with control devices on packaged equipment, such as liquid level controllers and multi-speed controllers.

.6 Supply and install all low and live voltage wiring associated with automatic control systems defined I Division 25 – Integrated Controls.

.7 Provide CSA labeling on all mechanical equipment with electrical components.

.8 Provide all on-site interconnecting wiring for connecting loose electrical components supplied with mechanical equipment.

.5 Division 26 (Electrical) Trade will:

.1 Supply and install all electrical components which are required, but not part of Division 22 and 23, supplied packaged equipment.

.2 Provide wiring interface from distribution equipment to variable frequency drives (VFDs) and from VFDs to motors.

.3 Extend power wiring from electrical centers to packaged equipment that contains electrical components.

.6 Refer to Division 26.

1.20 CUTTING AND PATCHING

.1 Provide inserts, holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

.2 Provide inserts or drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from Engineer before drilling, coring, cutting or burning structural members. Ensure post tensioned or pre-stressed strands are located accurately and avoid with an adequate margin of safety.

.4 Cutting practices shall be limited to neat openings created through recognized drilling or coring practices.

.5 Use only National Building Code approved and rated process and materials for filling of voids. All processes and materials are subject to the approval of the Fire Commissioner. Maintain integrity of fire separation.

.6 Provide openings and holes required in precast concrete members for mechanical work. Cast holes larger than 100mm (4”) in diameter. Field-cut holes smaller than 100mm (4”) if location is approved.

.7 Patch and make good building where damaged from equipment installation, improperly located holes etc. Work to be performed by the trade or contractor responsible for that type of work.

1.21 TEMPORARY HEAT

.1 Refer to Section 01 51 00 – Temporary Utilities.

.2 The building systems shall not be utilized for temporary heat. The contractor may provide a proposed temporary heat agreement to the Owner for review. However, the agreement may or may not be accepted, and as a minimum, the following requirements would have to be met:

  .1 The agreement shall include payment schedule for utilities, spare parts listing and confirmation of warranty.

  .2 Thoroughly clean and overhaul permanent equipment used during the construction period, and replace worn or damaged parts before final inspection at the sole discretion of the Consultant.

  .3 Use of permanent systems for temporary heat shall not modify terms of warranty. Equipment Manufacturers shall certify that equipment is in "new" condition at start of warranty period.

  .4 Operate heating systems under conditions which ensure no temporary or permanent damage. No water systems shall operate without proper water treatment or blow-down. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

  .5 Where air systems are used during temporary heating, provide filter media on return and exhaust air outlets. Clean duct systems which have become dirty. Provide additional sets of filters to replace temporary filters at final inspection.

  .6 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company monitoring system.

  .7 Avoid thermal shock to heating system during planning, construction and operation of temporary heating system.

1.22 TEMPORARY OR TRIAL USAGE

.1 Temporary or trial usage requested by the Owner of mechanical equipment supplied under contract shall not represent acceptance. Operate and maintain all equipment and systems during trial usage.

.2 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.3 For all ventilation systems, the operation of the system shall be pre-tested by running the units in their designed maximum fresh air, maximum exhaust air mode once all distribution ductwork is installed. Inspect filters bi-monthly; change filters if pressure drop exceeds manufacturer’s recommended operating limit.

1.23 SHOP DRAWINGS

.1 Comply with Division 01:

.1 Submittal Procedures Section 01 33 00

.2 Submit shop drawings and product data in accordance with Division 1 to consultant for approval prior to ordering material. Shop drawings are to be submitted electronically (PDF) and electronic copies will be provided in return with consultant comments and review stamp. Identify materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalogue material. Space must be left on the shop drawing to accommodate the Engineers review stamp. Where equipment is identified by name or number on the drawings or specification, clearly mark each shop drawing with the identical name and/or number.

.3 Prior to submission to the Engineer, the Contractor shall review all shop drawings. By this review, the Contractor certifies that he has determined and verified the following:

.1 Measurements are verified with field installation space requirements.

.2 “Handing” of equipment for access and maintenance is correct.

.3 Access for maintenance requirements is defined.

.4 Field connections for wiring, controls, piping and ductwork connections are defined.

.5 Electrical service connections and characteristics are defined.

.6 Work required by other trades is defined.

.7 Vendor’s catalogue numbers are correct and consistent with the system performance criteria.

.8 Shop drawings meet all requirements of the contract documents.

.4 The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a responsible person.

.5 Identify materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Engineers office. Maintenance and operating manuals are not suitable submittal material. Where equipment is identified by name or number on the drawings or specification, clearly mark each shop drawing with the identical name and/or number.

.6 Clearly mark each sheet of submittal material (using arrows, underlining, or circling) to show differences from what is specified, particularly sizes, types, model numbers, rating, capacities, and options actually being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pump seals, materials or painting.

.7 The shop drawings shall be complete with detailed wiring schematics, clearly showing the external electrical connections for power, control and communication. If generic wiring schematics are provided, they shall be marked up with the terminations and wiring requirements that are applicable and available only to this project. If wiring requirements and details are shown for optional equipment and/or devices, the optional equipment and/or devices shall be provided as part of the project.

.8 Where optional devices, equipment or features are indicated on the data sheets, the options shall be included as part of the project unless specifically marked up as not being provided for the project.

.9 Include dimensional and technical data sufficient to check if equipment meets requirements. Include wiring, piping, service connection data and motor sizes.

.10 Submittals shall be made in BOTH metric and English units.

.11 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.

.12 The shop drawing review by the Engineer will provide the following certification: "This review by Stantec is for general conformance with the design concept of Stantec's design of the Mechanical component(s) only and does not mean that Stantec has verified or approves the shop drawings(s). The contractor remains solely responsible for the shop drawings(s) and this review by Stantec does not relieve the Contractor of the Contractor's responsibility for errors or omissions in the shop drawings(s) or for meeting all requirements of the contract documents. This review does not mean that Stantec approve the detailed design inherent in the shop drawing, responsibility for which shall remain with the Contractor submitting same, nor does this review mean that Stantec accepts any deviation of the shop drawings(s) from the contract document. The Contractor is responsible for confirming all dimensions and correlating them at the job site, for all construction means, methods and techniques, and for coordination of construction work of all trades, including coordination of all shop drawings."

1.24 RECORD DRAWINGS

.1 Comply with Division 01:

.1	Closeout Procedures	Section 01 77 00
.2	Closeout Submittals	Section 01 78 00

.2 The contractor shall keep, on site, available to the Engineer at all times and particularly for each regularly scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of drawings is to be used only for this purpose, and must not be used as the daily general reference set. Make record drawings available for reference and inspection at all times.

.3 Provide record drawings which identify location of smoke and fire dampers, major control lines, access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include, in general, items that are significant or are hidden from view and items of major importance to future operations and maintenance, and to future alterations and additions including cleanouts and isolation valves.

.4 Include on drawings, all addenda and construction contract changes.

.5 Identify each drawing in lower right-hand corner in letters at least 12mm high as follows: "<u>RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED</u>", signature of contractor and date.

.6 The cost of producing and plotting the AutoCAD record drawings shall be included in the tender price. Periodic checks will be carried out to verify that the record drawings are being kept up to date.

.7 At substantial completion, transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, to AutoCAD 2013 files. Drafting quality layers, symbols, etc. shall be identical to original drawings. Prior to substantial performance, turn over a CD containing AutoCAD 2013 drawing files and one (1) complete set of hardcopy record drawings.

.8 Each "record" drawing shall bear the Contractor's identification, the date of record and the notation "We hereby certify that these drawings represent the "Work Record of Construction". The Contractor's signature and company seal shall be placed below that notation.

1.25 HVAC SYSTEMS TESTING AND STARTUP

.1 Conduct system startup and performance testing of HVAC systems.

.2 Quality Assurances

  .1 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.

  .2 Test procedures in accordance with applicable portions of ASME, ASHRAE, SMACNA and other recognized test codes.

  .3 Perform tests on site to the satisfaction of the Mechanical Consultant. Tests are to be witnessed by the Consultant and the Authorities Having Jurisdiction. Attendance at tests shall be at the discretion of the Consultant.

  .4 Piping or equipment shall not be concealed or covered until installation is inspected and approved by the Mechanical Consultant. Provide written notice to the Consultant at least three (3) days in advance of tests or concealing of piping.

.5 Coordinate with engineer at start of the project, those tests that will require witnessing by the Mechanical Consultant.

.6 Submit sample test certificate forms for review two (2) weeks prior to any testing on site.

.7 Should a test fail, make repairs and retest until the results are satisfactory to the Consultant and Authority Having Jurisdiction.

.3 Liability

.1 Take charge of plant during tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration in this connection.

.4 Submittals

.1 Obtain certificates of approval and acceptance, complying with rules and regulations from Authorities Having Jurisdiction. Submit copies to be included in Operating and Maintenance Manuals.

.2 Perform tests as specified. Include test certificates in Operating and Maintenance Manuals. Itemize each test as to the time performed and personnel responsible. Submit written report to the consultant within 48 hours after the tests have occurred.

.5 Execution

.1 Provide equipment, materials and labor for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy and date of calibration. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests for at least an 8-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 During heating and cooling, steam and condensate piping system tests, check linear expansion at elbows, U-bends, expansion joints and offsets, for proper clearance. Restrain manufactured expansion joints during hydrostatic tests in accordance with manufacturer’s recommendations.

.4 When using water as test medium for system not regularly using water or steam, evacuate and dehydrate the piping and certify the lines are dry following tests. Use agency specializing in this type of work.

.5 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by remaking joints in screwed fittings, cutting out and rewelding welded joints, remaking joints in copper lines. Do not caulk.

.6 Conduct all tests as work is completed and conditions permit, or on portions of systems as directed by consultant.

.7 Gas fired appliances to be subjected to Gas Inspection Branch operational tests.

.8 Visually check joints during tests for leakage of water test media or in systems with air or nitrogen tests check joints with soap bubble test.

1.26 HVAC EQUIPMENT TESTING AND STARTUP

.1 Conduct performance testing of equipment and arrange for manufacturer’s startup of equipment.

.2 Quality Assurance

.1 Use factory trained representatives and submit manufacturer's check sheets for starting all systems and equipment.

.2 Testing and certification of each backflow prevention device shall be by an "Approved Cross Connection Installation Specialist". One copy of the certificate to be submitted to the Water Purveyor, and one copy is to be inserted in each O & M manual.

.3 Prior to starting, testing, balancing, adjusting, and cleaning processes, verify with the Mechanical Consultant any tests required to be witnessed. Provide sufficient notice to the Mechanical Consultant prior to commencement of procedures.

.4 The Mechanical Consultant shall be allowed to witness any testing, adjusting, starting, balancing, and cleaning procedures.

.5 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.6 Prior to starting equipment or systems, secure and review manufacturer's installation, operation, and starting instructions. Read in conjunction with procedures defined herein.

.7 Use manufacturer's or supplier's starting personnel where required to ensure integrity of manufacturer's warranty.

.8 Compare installations to published manufacturer's data and record discrepancies. Items potentially detrimental to equipment performance shall be corrected prior to equipment starting.

.9 Some processes involved in starting procedures defined in this section may be duplications of Authorities verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures.

.10 All starting, testing, and procedures shall be in accordance with applicable portions of ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM, ASPE and as required and outlined in these specifications.

.11 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the readings and tests.

.12 Assume all liabilities associated with starting, testing and balancing procedures.

1.27 DEMONSTRATION AND OWNER'S INSTRUCTION FOR HVAC SYSTEMS

.1 Arrange for demonstration of plumbing, and HVAC equipment and systems operations.

.2 Arrange for instruction seminars for Owner's personnel.

.3 Comply with the requirements of Section 01 79 00 – Demonstration and Training.

.4 Quality Assurance

.1 The mechanical contractor shall arrange for sub-trades and manufacturer's representatives to be available for demonstrations and seminars.

1.28 OPERATION AND MAINTENANCE MANUALS

.1 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Mechanical Consultant at project milestones.

.2 Quality Assurance

.1 Work specified shall be performed by an Independent Agency specializing in this type of work.

.3 Approved Agencies

.1 The contractor is to submit a proposed agency for Consultant and Owner approval.

1.29 CERTIFICATE OF SUBSTANTIAL PERFORMANCE

.1 Comply with Division 00 and Division 01:

.1	Closeout Procedures	Section 01 77 00
.2	Closeout Submittals	Section 01 78 00
.3	Demonstration and Training	Section 01 79 00
.4	Demonstration and Training for Building Commissioning	Section 01 79 00.13
.5	General Commissioning (Cx) Requirements	Section 01 91 13
.6	Commissioning (Cx) Plan	Section 01 91 13.13
.7	Commissioning Forms	Section 01 91 13.16

.2 In addition to the requirements of Division 00 and Division 01, and prior to application for a "Certificate of Substantial Performance" of the work, the contractor shall certify the following in writing to the Consultant:

.1 The systems are installed and suitable for operation for the purpose intended.

.2 Plumbing, heating, ventilation and cooling systems are capable of operation with safety devices and alarm controls functional and automatic controls in operation and the Owners personnel have had their initial training programs.

.3 All equipment within mechanical rooms is installed.

.4 All thermal and acoustic insulation is installed.

.5 All static pressure tests are complete.

.6 All access doors are suitably located, and equipment easily accessible.

.7 All piping is installed, painted and clearly identified complete with flow arrows.

.8 Systems are chemically cleaned, flushed, and water treatment initiated.

.9 Temporary filters are removed, and permanent filters are installed.

.10 All equipment is checked for operation, alignment amperage draw and rotation.

.11 Rough balance of air and water systems is completed and the reports have been submitted for review.

.12 Equipment cleaned inside, outside and lubricated.

.13 All equipment is lubricated as per manufacturer's data.

.14 All equipment has been aligned by qualified millwrights.

.15 All valves are tagged and all equipment identified. Painting of equipment is completed and escutcheons are installed.

.16 All fans, pumps and equipment are installed and electrical connections made.

.17 All fire stop flaps, fire dampers, and smoke dampers are installed and checked for operation.

.18 All ducted supply/return/exhaust grilles are installed.

.19 All supply air, return air, exhaust air, outside air, and combustion air ductwork is installed and cleaned.

.20 All plumbing fixtures are installed, solidly supported and in operation. Domestic water lines are flushed and disinfected.

.21 Plumbing fixtures and brass have been cleaned.

.22 The building automation system seven (7) day acceptance test has been successfully completed.

.23 Noise and vibration control devices and flexible connections inspected by manufacturer's representative and written report submitted.

.24 All necessary tests and start-up procedures on equipment have been made, including those required by authorities.

.25 All contractor system start-up and test sheets have been completed and submitted for review.

.26 Warranty forms have been mailed to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one (1) year.

.27 Following information has been submitted:

.1 Final draft of O & M Manuals.

.2 Final certificates from authorities having jurisdiction.

.3 System cleaning reports.

.4 Reports from manufacturer on noise and vibration control devices.

.5 Completed record drawings.

.3 Identify any systems which cannot be installed and/or placed in operation for reasons beyond the normal control of the contractors and submit a statement of the value of the remaining work required to complete the project.

.4 Within ten (10) days of receipt of a written application for a "Certificate of Substantial Performance", the Engineer shall visit the site.

.5 If, after the Engineer's site visit the application for a "Certificate of Substantial Performance" is not approved, the contractor shall reapply in accordance with the Engineer's site visit report and pay for costs of re-inspection services.

1.30 CERTIFICATE OF TOTAL PERFORMANCE

.1 Comply with the requirements of Division 00 and Division 01.

.2 Prior to application for a statement of "Total Performance", the Contractor shall certify the following in writing to the Engineer:

.1 All items noted in previous site visit reports including that performed for Substantial Performance have been completed.

.2 Warranty forms are mailed to manufacturer. (Provide copy of original warranty for equipment which has a warranty period of longer than one year).

.3 Completed and accepted Operating and Maintenance (O & M) Manuals have been submitted to Owner.

.4 Completed and accepted final air and water Balancing Reports have been included in the O & M Manuals.

.5 The Owner has received instructions in the operation and maintenance of the system.

.3 Within ten (10) days after receipt of a written application for a "Certificate of Total Performance", the Engineer shall visit the site.

.4 The Engineer shall provide one (1) visit for the purpose of reviewing the application for a "Certificate of Total Performance". Subsequent visit(s) if required, shall be at the expense of the contractor.

1.31 CONTRACT PRICE BREAKDOWN

.1 Submit a breakdown of the contract price using the following form within fourteen (14) days of contract award and well before first progress claim for review and approval by Engineer.

.2 Progress Claim shall be submitted using this Contract Price Breakdown Format.

	Contract Amount	% Complete	Total to Date	Previous Claim	This Claim
1. Bonding					
2. Supervision					
3. Project Overheads					
4. Documentation					
5. Balancing					
6. Pre-operational Cleaning					
7. Plumbing					
8. Heating					
9. Cooling					
10. Ventilation					
11. Humidification					
12. Insulation					
13. Meters & Gauges					
14. Breeching & Chimneys					
15. Duct Cleaning					
16. Controls					

Part 2 Products

2.1 OPERATING AND MAINTENANCE MANUALS

.1 Comply with Division 01:

.1 Closeout Procedures Section 01 77 00

.2 Closeout Submittals Section 01 78 00

.2 Binders

.1 Provide four (4) sets of Operations and Maintenance Manuals.

.2 Each set of manuals shall include as many binders as required to accommodate the project information.

.3 Binders shall be 216mm (8½") x 280mm (11"), three (3) post, expanding spine type, with metal piano hinges and bound with heavy fabric.

.4 Maximum binder thickness when filled shall not exceed 100mm (4"), including a space allowance for 10% additional data.

.5 Binder color shall be blue, Ontario buckram fabric, color #OBV460.

.6 Project title and identification shall be silk screened on the front cover and spine. All lettering and borders shall be white.

.7 Binder spine identification to include Volume #, Set #, Title Description, Facility Name and Facility Location. Title of the project is to be as per title on drawings cover sheet.

.8 Contractor to submit proof of cover layout for review prior to ordering binders.

.9 In addition to the hard copies, an electronic version of the Operating and Maintenance manuals are to be provided in PDF on a CD.

.3 Tabs

.1 The divider tabs shall be laminated mylar plastic and colored according to division and section.

.2 Plastic tabs with typewritten card inserts will not be accepted.

.3 Each tab to include tab number and title printed on the tab.

.4 The coloring for tabs for individual sections is as follows:

Green:	Air Systems
Brown:	Control Systems
Blue:	Cooling Systems
Orange:	Heating Systems
Yellow:	Miscellaneous Systems
Purple:	Plumbing Systems
Gray:	Steam Systems

.4 Manual Divisions

.1 Organize each manual into the following divisions.

.1 Operation Division

.2 Maintenance Division

.3 Contract Documentation Division

.5 Operations Division

.1 The operations division shall have all data organized into sections according to the system category with individual divider tabs as follows:

.1 AIR - Air Systems

.2 CTL - Control Systems

.3 CLG - Cooling Systems

.4 HTG - Heating Systems

.5 MIS - Miscellaneous Systems

.6 PLG - Plumbing Systems

.7 STM - Steam Systems

.2 Organize data for each system category (section) into individual sub-systems. Provide an index for each system category and a divider tab for each individual system.

.3 For each individual sub-system include the following:

.1 System Description - Provide details of system type, composition, areas served, location in the building, design criteria and function of major components. All equipment arranged to operate together as one system shall be considered part of that system description. Design criteria shall, at minimum, include the following:

.1 Outdoor ambient conditions

.2 Air circulation rate

.3 Exhaust air rate

.4 Minimum outside air

.5 Building pressurization

.2 System Schematics - Provide a system schematic showing all components comprising the central system. Identify each component using DDC system mnemonic and generic name designation. Use this equipment designation in all references to the equipment throughout the manual.

.1 System schematics shall include at a minimum:

1. Hot water/glycol heating system
2. Chilled water/glycol cooling system
3. Ventilation systems

.3 Operating Instructions - Provide, in "operator" layman language, the specific instructions for start-up, shutdown and seasonal change over of each system component. Include exact type and specific location of each switch and device to be used in the system operation. Identify safety devices and interlocks that must be satisfied in order for the equipment to start. Also, list conditions to be fulfilled before attempting equipment start-up, i.e. valves position correct, glycol mixture concentration proper, piping filled with fluid, filters/strainers in place, etc.

.4 Maintenance Division

.1 Organize data into the following sections with divider tabs:

1. Maintenance Tasks and Schedules
2. Spare Parts
3. Suppliers and Contractors
4. Tags and Directories

.2 Maintenance Tasks and Schedules - Organize data according to the system category, with further breakdown into individual systems as used in the operations division of the manual. Provide section index and divider tabs for each system category. Summarize maintenance tasks from manufacturers maintenance brochures, for each component of each system in the following format:

1. Daily
2. Weekly
3. Monthly
4. Semiannually
5. Annually
6. When Required.

.3 Spare Part List - Organize data according to the system category, with further breakdown into individual systems as used in the operations division of the manual. Provide section index and divider tabs for each system category. Summarize from manufacturers maintenance brochures the recommended spare parts for each component of each system.

.4 Suppliers and Contractor List - Provide summary of Suppliers and Contractors for each components of each system. List name, address and telephone number of each.

.5 Tags and Directories - Provide a copy of the Mechanical Drawing, List, Valve Tag List, Piping Identification Schedule and all other directories as specified in the contract documents.

.5 Contract Documentation Division

.1 Organize all data required by the construction contract into sections, with divider tabs, as follows:

1. Drawings List
2. Shop Drawings and Product Data
3. Certifications
4. Warranties and Bonds
5. Maintenance Brochures
6. Reports

.2 Shop Drawings and Product Data - Provide final copies of all shop drawings and product data required by the contract documents. Include section index and divider tabs. Maximum of twenty-five (25) sheets or one (1) system shop drawing per tab.

.3 Certifications - Provide copies of Contractor Certifications for the performance of product and systems. Include copies of all pressure tests for piping and ductwork systems, equipment alignment certificates, local authority inspection reviews, backflow prevention certification, and fire protection certifications. Include section index and divider tabs with maximum of twenty-five sheets (25) or one report per tab.

.4 Warranties and Bonds - Include one copy each of the Contractor's warranty, manufacturers' warranties longer than one year, the bond, and any service contract provided by the contractor. Provided section index.

.5 Maintenance Brochures - Include copies of all manufacturers' printed maintenance brochures pertaining to each product, equipment or system. Provide section index and divider tabs. Maximum of twenty-five (25) sheets or one system brochure per tab.

.6 Reports - Include copies of all reports relating to the testing, adjusting and balancing of equipment and systems, water treatment reports and manufacturer’s start-up reports, as required by the contract specification sections.

.6 Submissions and Approvals

.1 First Draft Submission

1. Contractor shall submit a draft copy of the operations and maintenance manuals for format review at the 50% construction completion stage.

2. The draft submission is to be submitted as a single, compiled PDF. Separate PDFs of the documents will not be accepted.

3. The PDF is to be organized and bookmarked to match the Operation, Maintenance, and Contract Documentation Divisions noted above and as follows.

   .1 A table of contents for the complete manual.

   .2 Index of each division of the manual.

   .3 Index of each section of the operations and maintenance divisions.

   .4 A sample operations division write-up for a typical system, including sample schematic.

   .5 A sample maintenance division write-up for the same typical system.

   .6 Sample proof of binder covers and spines.

4. On completion of review of the first draft submission the consultant will return a copy of the PDF manual with review comments for resubmission.

.2 Provisional Edition

1. The contractor shall submit a provisional edition of the manual at the 75% construction completion stage.

2. The provisional submission is to be submitted as a single, compiled PDF. Separate PDFs of the documents will not be accepted.

3. The provisional edition shall be complete in all respects, except for reports and certificates to be produced during the facility start-up phase. This manual shall be submitted in PDF format. The PDF shall be bookmarked to match the divider tabs and indices of the final edition of the manual.

4. On completion of review of the provisional edition submission the consultant will return a copy of the PDF manual with review comments.

5. One hard copy of the provisional edition shall be kept on site as an interim reference for all parties engaged in the

facility start-up phase and shall be used to familiarize and train the operating staff.

6. The contractor shall update contents of the site copy of the provisional edition manual as new information is generated during the facility start-up phase.

.3 Final Edition

1. Prior to final acceptance the contractor shall submit four (4) copies of the final edition of the manual to the client.

2. In addition to the hard copies, a PDF of the final edition of the O&M manual is to be sent to the client and mechanical consultant.

3. This final edition shall include all outstanding project information and conform to all requirements listed in this document.

Part 3 Execution

3.1 DEMONSTRATIONS – GENERAL

.1 Mechanical Trade shall arrange for presentation and demonstration of plumbing, and HVAC equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

.2 Coordinate demonstration and instruction agenda and schedule with the Owner and Engineer.

.3 Coordinate demonstration and instruction agenda and schedule for work performed outside the contract with the owner and engineer.

.4 Provide personnel when necessary to ensure proper detailed training is provided for all mechanical systems.

.5 Do not commence the instructional period until all mechanical systems are complete and proven operational.

.6 Include in the operating and maintenance manuals all instructions and information given to owner's staff and instructions and information given by equipment manufacturer's representatives.

3.2 DEMONSTRATIONS – EQUIPMENT & SYSTEMS

.1 Demonstrate specific starting and stopping and general maintenance requirements for each major piece of equipment. Ensure all labeling and identification is completed.

.2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

.1 Air Systems

.2 Control Systems

.3 Chemical Treatment Systems

.4 Steam Systems

.5 Balancing

.3 Demonstrate the following pieces of equipment.

.1 Steam Boilers

.2 Chillers

.3 Fans/Air Handling Units

.4 Refer to sample mechanical system agenda schedules in section 3.3 following for identifying the proposed sequence of demonstrations. Sequence of demonstration and duration of training seminars to suit project. Submit agenda for review by Engineer one month prior to demonstration.

.5 Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

.6 Provide sign off sheets for each session. Sign off sheets to have attendees, date, subject, presentation by and comments. Attach the sign off sheets to the agenda and submit a copy to the engineer following training seminars.

3.3 MECHANICAL SYSTEMS AGENDA (SAMPLE)

Mechanical Systems Agenda

Topic: Heating System

Day:
1. Start Time: 8:00 am
2. Meeting Place: ______________

Approximate Duration: 7.5 hours

Agenda:
1. 8:00am – Classroom Presentation
2. Contractor / Supplier: ______________

Lunch Break: 12:00pm to 1:00pm

Agenda:
1. 1:00pm – Site Walkthrough
2. 4:00pm – Final Questions and Sign-off Log Sheet

Personnel to be in Attendance:
1. Mechanical Contractor and Sub-Trades (as required)
2. Maintenance Staff

Presentation Format:

Classroom:

Introduction:

1. Pass out hand-outs of system description
2. Reference to equipment operation brochures as required
3. Detailed system overview by Mechanical Trade, Sub-Trades and Suppliers
4. Review of system installations by the Mechanical Trades using record drawings

Site Tour:

1. Mechanical Trade to outline location of main piping runs, isolation valves, service access points.
2. Review service procedures for heating boiler and circulation pumps.
3. Terminal hot water heating units to be reviewed for service and operation.
4. Coils, expansion tanks and accessories to be reviewed for service and operation.
5. Equipment to be reviewed and dismantled as required to demonstrate servicing.
6. Gas Fired equipment to be reviewed and dismantled as required to demonstrate servicing and operation.
7. Provide written instructions on how to start and stop all equipment and demonstrate using instructions during tour.

3.4 HVAC EQUIPMENT TESTING AND STARTUP – GENERAL

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.

.2 Meet with Division 26 manufacturers, suppliers, and other specialists as required to ensure all phases of work are properly coordinated prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.

.3 Gas fired appliances rated in excess of 17 kW (400 MBH) shall be subjected to an operational test established by the Gas Protection Branch and shall pass this test before being approved for operation.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check overload heaters in motor starters are within the constraints of Division 26 requirements. Replace heaters if required to suit as installed condition.

.5 Confirm voltages and operating amperages at full load.

.6 Tests to be maintained for a period of eight (8) hours minimum for each system. Test for air and water flow and temperature and humidity to demonstrate compliance with design requirements.

.7 During test, make adjustments to bring equipment up to the required standards with respect to performance, vibration, noise, etc.

.8 Conduct final operating tests in presence of the owner. Vary loads to illustrate start-up and shut down sequence and simulate emergency conditions for safety shut downs, with automatic and manual reset. Repair and test defects until satisfactory. Make final adjustments to suit exact building conditions.

.9 Provide services of one job mechanic, ladders, tools and associated equipment required to assist in final tests. Owner’s personnel may witness all tests.

.10 Lubricate bearings, adjust and/or replace and set direct and ‘V’ belt drives for proper alignment and tension.

.11 Calibrate and adjust thermostats, thermometers and gauges. Control valves shall operate freely.

.12 Remove and clean strainers.

.13 Fasten loose and rattling pieces of equipment. Pumps and other equipment shall operate quietly.

.14 Failure to follow instructions pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by Owner at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.5 HVAC EQUIPMENT TESTING AND STARTUP – PROCEDURES

.1 Procedure shall be identified in the following five (5) distinct phases:

- .1 Pre-Starting: Visual inspection.
- .2 Starting: Actual starting procedure.
- .3 Post-Starting: Operational testing, adjusting or balancing, and equipment run-in phase.
- .4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.
- .5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.

.2 Check specified and shop drawing data against installed data.

.3 Check the installation is as defined by contract documents and as per manufacturer's recommendations including manufacturer's installation check sheets.

.4 Include for the costs of an independent testing agency, selected by the Owner, to take samples of all chemically treated hydronic systems, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should chemical treatment levels not meet the requirements of the specifications, the Contractor shall adjust treatment levels accordingly and cover the costs of the independent testing agency to take additional samples and tests.

3.6 HVAC EQUIPMENT TESTING AND STARTUP – CONTRACTOR TESTING RESPONSIBILITIES

.1 The contractor shall be required to provide the following tests as part of his construction contract. For each test, a test form is to be filled out, witnessed, kept on site for the consultant to verify at any time during construction and then they are to be included in the final submission of the contractor O & M manuals.

.1 Plumbing Systems

.1 Piping

.1 Test as per the requirements of the National Plumbing Code 2015.

.2 Water Softening Equipment

.1 Acceptance tests to prove performance guarantee

.2 Air Systems

.1 Fans

.1 Check radiated and discharge sound power levels

.2 Determine rpm, air flow rates, static pressure and record on the fan curves

.3 Conduct fan performance test for total system volume on main air supply and exhaust units

.2 Fire Dampers

.1 Test each damper to ensure proper blade movement and damper closure

.2 Verify damper accessibility for changing of the fusible links

.3 Ductwork

.1 Low pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Section 23 31 13 – Metal Ducts.

.2 Medium and high pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Section 23 31 13 – Metal Ducts.

.3 Steam System

.1 Low Pressure Steam

.1 Test piping to 690 kPa (100 psi) for eight (8) hours

.4 Hydronic Heating System

.1 Boilers

.1 Start up boilers as per manufacturers recommendations

.2 Set up and adjust burner operation through all firing rates, and record efficiencies

.2 Control Valves

.1 Record pressure drops across each valve

.3 Piping

.1 Test to 1½ times the working pressure or a minimum 1035 kPa (150 psi), whichever is greater, for eight (8) hours. Water pressure to be measured at system low point.

.4 Chemical Treatment System

.1 Acceptance tests by independent lab to provide performance guarantee

.5 Cooling System

.1 Pumps & Piping

.1 All tests shall be the same as the hydronic heating system

.2 Chemical Treatment System

.1 Acceptance tests by independent lab to provide performance guarantee

.6 DDC Control System

.1 General

.1 Conduct system 7 day performance test to prove communication, loop tuning and control sequences

.2 Variable Frequency Drives

.1 Test as per the requirements of Section 23 05 14 – Variable Frequency Drives for HVAC Equipment.

3.7 SUBSTANTIAL COMPLETION CHECKLIST

.1 The following items must be completed, and documentation submit prior to requesting a walk through for the mechanical C2.

MECHANICAL C2 SUBSTANTIAL COMPLETION LIST	
ITEM	**Report or Documents Required?**
DIV. 22 – PLUMBING	
All major plumbing equipment start ups completed and commissioned. Start up and test sheets provided.	Y
All plumbing fixtures installed, solidly supported and in operation	
Pressure testing for sanitary, storm, domestic water and gas has been completed	
Water supply, drain, waste and vent systems are complete and operational	
Sanitary facilities and sump pumps are in place and functional in all areas	
Storm facilities and sump pumps are in place and functional in all areas	
Domestic water heater and plumbing equipment tested and commissioned	
Domestic water lines are flushed and disinfected. Water quality test report provided.	Y
DIV. 23 – HVAC	
All major HVAC equipment start-ups completed and commissioned. Start up and test sheets provided.	Y
Building under full automation control. 7 day acceptance and sequence of operations testing completed. Provide letter of completion.	Y
All required fire dampers, fire stop flaps and smoke dampers have been installed and tested and included in testing and balancing report or letter.	Y
All required fire wrap has been completed	
Gas detection systems have been tested and calibrated	Y
All terminal heating equipment operational and enclosures installed	
All duct static pressure tests completed	
All hydronic and refrigeration pressure tests completed	
All hydronic systems chemically cleaned, flushed and water treatment initiated	
All ductwork and associated grilles and diffusers have been cleaned and installed	
All ductwork has been installed and cleaned	
All temporary filters have been removed and replaced with new	
OTHER	
Integrated systems testing completed and verification letter provided	Y
Testing and balancing completed c/w letter or report showing completion	Y
All thermal and acoustic insulation is installed.	
Noise and vibration control devices and flexible connections installed and inspected	
All access doors are suitably located and equipment easily accessible	
All fire stopping completed	
Preliminary O&M manual or O&M table of contents has been submitted	Y

END OF SECTION

Part 1 General

1.1 SCOPE

.1 This section covers general motor requirements for factory and field installed motors.

.2 Refer to individual sections for application of motors and reference to specific motor requirements for motor driven equipment.

.3 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on mechanical equipment schedules on mechanical drawings.

.4 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

.5 Motors shall be suitable for horizontal, vertical or belt driven mounting.

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Variable Frequency Drives for HVAC Equipment	Section 23 05 14
.3	Air Handling Units – Built-Up	Section 23 73 00.13
.4	Electrical	Division 26

1.3 REFERENCE STANDARDS

.1 Air-Conditioning, Heating, and Refrigeration Institute

  .1 ANSI/AHRI Standard 110 — Air-conditioning and refrigerating equipment nameplate voltages

.2 American National Standards Institute (ANSI)

.3 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

  .1 ASHRAE 90.1 — Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).

.4 Electrical Equipment Manufacturers' Association Council (EEMAC)

.5 Canadian Standards Association

  .1 CSA 22.1, part 1 — Safety Standard for electrical installations

.2 CSA 22.2 No. 140.2-96 (R2006) Hermetic refrigerant motor-compressors; (also refer to UL Standard 984; Hermetic refrigerant motor-compressors)

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.7 Institute of Electrical and Electronic Engineers (IEEE)

.8 National Electrical Manufacturers Association (NEMA)

1.4 QUALITY ASSURANCE

.1 All motors shall be ULC listed and CSA certified.

.2 All motors to be approved for use in the designated area classification by the Electrical Protection Branch, Alberta Department of Labor.

.3 Full Voltage Start Applications:

.1 All motors shall be in accordance with NEMA standards, and CSA C390-93, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.

.4 Variable Frequency Drive and Soft Start Applications:

.1 Where equipment is noted to be controlled by a VFD on the equipment schedules, or in other Sections, the motors shall be in accordance with NEMA standards (MG-1) Part 31, and inverter duty class, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.

.2 Motors connected to VFD(s) shall be wound using inverter spike resistant magnet wire capable of 1600V.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Shop Drawings:

.1 Submit shop drawings for motor driven equipment, as required by equipment specification sections. Motor shop drawing information shall include, but not be limited to the following:

.1 Voltage/Phase./Hertz

.2 Motor power (kW or Watts)

.3 Full load amps

.4 Wiring diagrams (as required)

1.6 CLOSEOUT SUBMITTALS

.3 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.4 Product Data:

.1 Refer to shop drawing requirements above.

.5 Operation and Maintenance Manuals:

.1 Operation Data: Include instructions for safe operating procedures.

.2 Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 TESTING

.1 Production Tests: Each motor shall receive a routine commercial test per NEMA MG-1.12. Prototype test reports shall be for each rating.

.2 Sound Level: The noise level of each motor shall comply with NEMA MG-1.12.49.

.3 Vibration Level: The vibration level of each motor shall not exceed those values listed in NEMA MG-1.12.05.

1.8 VARIABLE SPEED DRIVES

.1 Motors shall be designed for operation with Variable Frequency Drives as noted on the motor schedule.

1.9 DELIVERY & STORAGE

.6 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.10 WASTE MANAGEMENT AND DISPOSAL

.7 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL REQUIREMENTS

.1 Provide motors for mechanical equipment as specified.

.2 Unless noted otherwise, provide open drip-proof, ball or roller bearing motors with grease fittings.

.3 Motors shall have standard voltage ratings consistent with the project distribution voltages.

  .1 Motors 0.372 kW (½ HP) and less to be 120 volt, 60 cycle, single-phase power.

  .2 Motors 0.559 kW (¾ HP) and larger to be 3 phase power and for the scheduled voltage.

  .3 Confirm electric voltage, phase and starter requirements with the electrical specifications.

  .4 Refer to equipment schedules on drawings.

.4 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.5 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.6 Provide all motors with terminal boxes, suitable for power connections.

.7 Provide screw adjustable bases on all belt-connected motors.

.8 Motors shall be of the capacitor start type when they may be manually cycled from a starting switch which is located in the finished space.

.9 Motors exposed to outdoor temperature to be lubricated with lubricants suitable for operation at 6°C below the lowest temperature recorded by ASHRAE or the Climatic Information (Supplement to the National Building Code), for the location in which they are installed.

.10 Refer to electrical specifications for voltage, frequency, and phase data. This shall take precedence over any reference in Division 23. Packaged equipment shall have connections as specified in Division 26.

.11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

2.2 VOLTAGE AND FREQUENCY

.1 Motors will be rated for operation on a 1-phase or 3-phase, 60 Hz power supply at 115 Volts, 208 Volts or 575 Volts. All motors shall be designed and manufactured to operate with ±10% voltage and ±5% frequency variations of the nameplate ratings. Combined voltage and frequency variation shall not exceed ±10%. Confirm voltage for all motors with Division 26.

2.3 TORQUE

.1 Motors shall meet or exceed the locked rotor (starting) and minimum breakdown torques specified in NEMA standard for Design B for the ratings specified.

2.4 CURRENT

.1 Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to the motor components.

2.5 EFFICIENCY

.1 Motors shall be Premium Efficient design and have a minimum and nominal full load efficiency which will meet or exceed the values listed in NEMA MG1-12.55 Table 12-6B when tested in accordance with NEMA test standard MG1-12.54.1, IEEE Test Procedure 112, Method B using accuracy improvement by segregated loss determination including stray load loss measurements. The minimum efficiency shall be guaranteed.

.1 Premium efficiency open drip-proof motors shall have the following typical full load efficiencies (nominal):

kW (HP)	Premium Efficiency - Minimum Efficiency (%)		
	3600 RPM 2 Pole	1800 RPM 4 Pole	1200 RPM 6 Pole
0.746 (1)	74.0	82.5	80.0
1.12 (1.5)	81.5	84.0	84.0
1.49 (2)	82.5	84.0	85.5
2.24 (3)	82.5	87.5	86.5
3.73 (5)	84.0	87.5	87.5
5.59 (7.5)	86.5	89.5	88.5
7.46 (10)	87.5	90.2	90.2
11.2 (15)	88.5	91.7	90.2
14.9 (20)	89.5	91.7	91.0
18.6 (25)	90.2	92.4	91.7
22.4 (30)	90.2	93.0	92.4
29.8 (40)	91.0	93.0	93.0
37.3 (50)	91.7	93.6	93.0
44.7 (60)	92.4	94.1	93.6
55.9 (75)	92.4	94.1	93.6
74.6 (100)	92.4	94.5	94.1
93.2 (125)	93.0	94.5	94.1
111.9 (150)	93.0	95.0	94.5

.2 Premium efficiency totally enclosed fan cooled motors shall have the following typical full load efficiencies (nominal).

kW (HP)	**Premium Efficiency - Minimum Efficiency (%)**		
	3600 RPM 2 Pole	**1800 RPM 4 Pole**	**1200 RPM 6 Pole**
0.746 (1)	74.0	82.5	80.0
1.12 (1.5)	81.5	94.0	85.5
1.49 (2)	82.5	94.0	86.5
2.24 (3)	84.0	87.5	87.5
3.73 (5)	86.5	87.5	87.5
5.59 (7.5)	87.5	90.2	89.5
7.46 (10)	88.5	90.2	89.5
11.2 (15)	89.5	91.0	90.2
14.9 (20)	89.5	91.7	90.2
18.6 (25)	90.2	92.4	91.7
22.4 (30)	90.2	92.4	91.7
29.8 (40)	91.0	93.0	93.0
37.3 (50)	91.7	93.6	93.0
44.7 (60)	92.4	94.1	93.6
55.9 (75)	92.4	94.5	93.6
74.6 (100)	93.0	94.5	94.1
93.2 (125)	94.1	94.5	94.1
111.9 (150)	94.1	95.0	95.0

2.6 SOUND LEVEL

.1 The noise level of each motor shall comply with NEMA MG-1.12.49.

2.7 VIBRATION LEVEL

.1 The vibration level of each motor shall not exceed those values listed in NEMA MG-1.12.05.

2.8 SERVICE FACTOR AND AMBIENT

.1 Standard motors shall be rated for a 1.15 service factor in a 40°C (104°F) ambient unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection. Motors 30 kW (40 HP) and larger shall have thermistor protection.

2.9 INSULATION

.1 Standard motors shall have a full Class F non-hygroscopic insulation system.

.2 Standard motors shall be dipped and baked in a non-hygroscopic polyester high temperature varnish, spike resistant for motors connected to VFDs and soft-starts (NEMA MG-1 Part 31).

.3 Moisture resistant (MR) copper magnet wire rated for 200°C (392°F) or better.

2.10 NAMEPLATES

.1 Nameplates shall be of stainless steel and stamped per NEMA Standard MG1-10.40. Nameplate information shall include the nominal efficiency value per standard MG1-12.54.2.

2.11 BELT DRIVES

.1 Provide belt drives to the following requirements:

- .1 Provide steel, cast iron or aluminum sheaves for motors less than 0.559 kW (3/4 HP).
- .2 Provide steel or cast iron sheaves keyed to shafts, for motors 0.559 kW (3/4 HP) and larger.
- .3 For motors less than 7.46 kW (10 HP) provide standard adjustable pitch drive sheaves having +/-10% range. Use mid-position of range for specified RPM.
- .4 For motors 7.46 kW (10 HP) and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.

.2 Match drive and driven sheaves.

.3 V-belts shall conform to the American Belt Manufacturers standards. Multiple belts shall be matched sets.

.4 Not less than a 2-belt configuration is required for each drive for motors 0.559 kW (3/4 HP) and larger.

2.12 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives;

- .1 Expanded metal screen welded to steel frame.
- .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
- .3 38mm (1½”) diameters holes on both shaft centres for insertion of tachometer.
- .4 Removable for servicing.

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

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

.2 Securely fasten in place.

.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

.2 Net free area of guard: not less than 80% of fan openings.

.3 Securely fasten in place.

.4 Removable for servicing.

Part 3 Execution

3.1 GENERAL

.1 Unless otherwise noted starters and protection devices will be included under the Electrical Division of the Specification.

.2 Assist Division 26 to ensure proper connection, correct thermal overload protection and correct motor controls.

.3 Where starters are included in this Division as an integral part of packaged equipment, they shall contain thermal overload protection in all ungrounded lines.

.4 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch.

.5 If delivery of specified motor will delay delivery or installation of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not be given until specified motor is installed.

.6 Make removable for servicing, easily returned into, and positively in position.

3.2 MANUFACTURER’S INSTRUCTIONS

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

3.3 SETTING AND ALIGNMENT

.1 Employ a journeyman millwright to align all V-belt drives and/or shaft coupling drives prior to initial start-up. The millwright shall also check that centrifugal fan wheels are properly centered on fan shafts.

.2 Align shaft couplings, using a dial indicator, to within +/-0.051 mm (0.002") after grouting is complete and the piping system is operational.

.3 Align V-belt drives using a straight edge.

.4 Submit a certificate from the millwright employed, certifying that all shaft couplings and V-belt drives have been aligned and centrifugal fan wheels centered prior to initial start-up and checked again after final system balance adjustment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 This section includes the supply, installation, start-up, testing and commissioning for variable frequency drives (VFD) controllers, including but not limited to: associated enclosures, input and output filters, warranty, local and remote control.

.2 The VFD and all specified components, including internal wiring between those components, must be installed and integrated into one common enclosure, supplied, factory tested, and commissioned by the VFD supplier. The integrated VFD assembly shall be ready for filed installation and require only the connection of the incoming power cables, the motor load cables, and the control wiring for start-up, and the commissioning of the VFDs.

.3 The VFD supplier must coordinate with the installation contractor with respect to delivery dates, technical support for the installation, equipment start-up, and the commissioning of the VFDs.

.4 All drives and ancillary components specified in this section to be supplied by one manufacturer to assure a properly coordinated system.

.5 Design all equipment using modularized solid state equipment to allow easy maintenance and replacement.

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Common Motor Requirements for HVAC Equipment	Section 23 05 13
.3	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.4	Electrical	Division 26

1.3 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA)

.1	CSA 22.1, part 1	Safety Standard for electrical installations
.2	CSA 22.2	Canadian Electrical Code

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

.3 Institute of Electrical and Electronic Engineers (IEEE)

.1	Standard 519	Guide for Harmonic Content and Control.

.4 International ElectroTechnical Commission (IEC)

.1	IEC 61800	Adjustable Speed Electrical Power Drive Systems

.5 National Electrical Manufacturers Association (NEMA)

.1 ICS 7-2014 Adjustable Speed Drives.

.2 ICS 61800 Adjustable Speed Electrical Power Drive Systems.

.3 MG1 Motors and Generators

.6 Underwriters Laboratories (ULC)

.1 UL 508A Standard for Industrial Control Panels

.2 UL 508C Power Conversion Equipment

1.4 QUALITY ASSURANCE

.1 VFD units shall be ULC listed and CSA (or cUL) certified.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings that include, at a minimum, the following information:

.1 Catalog and technical data.

.2 Outline dimensions, shipping section dimensions, weight, and foundation requirements for all assemblies.

.3 Physical details of the cabinets, a wiring diagram, and a ladder diagram showing both internal connections and terminals for field wiring, showing function and identification of all terminals requiring field connections. Separate diagrams are required for each VFD size. Generic diagrams are not acceptable.

.4 Component fabrication drawings consisting of detailed circuit schematics, indicating all components in the VFD package, including line and load reactor impedance ratings and/or filter design type, VFD current, HP and voltage rating.

.5 Bolt and lug torque schedule for all power and control wiring termination points.

.6 Vendor’s start-up sheets for the drive.

.4 Upon delivery, provide as-built shop drawings for each unit. A copy of the as-built shop drawings shall be provided for each drive, in addition to one set of drawings for each copy of the O&M Manuals. (See info in the project specifications and drawings for quantities in addition to that indicated herein, the quantities shall be the maximum indicated plus 1 copy for each drive).

1.6 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Product Data:

- .2 Refer to shop drawing requirements above.

.3 Field Test Reports:

- .3 Provide vendor startup sheets

.4 Operation and Maintenance Manuals:

- .1 Supply four (4) copies of Operation and Maintenance manual containing data for each VFD. Data shall include:

  - .1 Troubleshooting charts for all device faults.
  - .2 An instruction manual for: programming and the hardware provided with the equipment at time of shipment.
  - .3 Manufacturer’s start-up check sheet(s) with list(s) that outline all of the completed tasks. Check-sheets are to contain actual start-up data and shall list all settings and parameters present in the drive unit as commissioned.
  - .4 VFD field-test measurement results. All data provided shall be that from the last testing conducted on the drive. If original testing was redone, then the new data shall be provided in addition to the original data Original tests must then be marked “Superseded. For Information Only”. All test data shall be dated and signed".
  - .5 Settings sheets to record all VFD configuration options and selections for VFD set-up. Settings sheets are to contain actual start-up data and shall list all settings and parameters present in the drive unit as commissioned.
  - .6 Include a list of authorized recommended spare parts, service depots, spare parts list.

- .2 Provide copies of the VFD programming / troubleshooting software, as well as any connection cables required, to Owner. Provide one set of software and cabling, for each size of drive, for each O&M manual provided.

1.7 INTENDED OPERATION

.1 The VFD shall be designed to operate standard squirrel cage induction motors with a 1.0 service factor meeting NEMA MG1 Part 31. Refer to Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

.2 The VFDs shall control one of more fan motor(s) or pump motor(s) as listed in the drawing schedules.

.3 The VFD shall communicate with, and be controlled by, the building management system (BMS) which will provide Run Command and an Operating Speed reference to the VFD. VFD Run Status, Operating Speed, Load Amps, Power and Alarm or Fault data shall be communicated back to the BMS. The VFD shall also be capable of operating in PID Mode with the Run Command and PID Set Point communicated by the BMS. A process monitoring transmitter (supplied by the controls contractor) will be connected directly to the VFD. Refer to Controls, Sections 23 09 Series.

.4 Communication with the BMS shall be BACnet MSTP over EIA-485.

1.8 FACTORY TESTING

.1 Prior to shipment, all VFD units are to be shop-tested at the factor or at the VFDs OEM/integrator’s facilities. Testing shall include, but will not be limited to, a complete functional test to fully prove out the VFD and all the local and remote control functions and required parameter settings. Phase-loss protection for each of the 3 phases of the VFD shall be proven as part of the factory testing.

.2 Provide factory-certified copies of production test results to the Engineer prior to shipment of the equipment.

1.9 HARMONIC GUIDELINES

.1 All VFD installations shall meet IEEE-519 harmonic guidelines.

.2 Following award of contract, and prior to submitting shop drawings, the VFD vendor shall review the electrical system design and MCC locations and advise if filtering, in addition to the specified line reactors, is required.

1.10 WARRANTY

.1 The VFD supplier shall provide warranty coverage for a minimum period of twelve (12) months commencing upon the date of substantial completion. Refer to Division 0 and Division 1.

.2 The Vendor shall be responsible to bring a Factory Representative back to reset, repair, and re-commission the VFD if problems arise with the normal operation of that VFD during the warranty period.

1.11 MAINTENANCE

.1 VFD supplier is to include a preventative maintenance program (PMP) for a one year period. The PMP is to be broken down to daily, weekly, monthly and annual service periods. Each service period is to include all manufacturer recommended maintenance tasks which should be completed in each period. A maintenance checklist is to be cross referenced to the maintenance period and maintenance task.

1.12 TRAINING

.1 Provide an on-site, half day training seminar for maintenance and service personnel.

.2 The VFD supplier shall detail an agenda for the training to be provided and to present it to the Engineer for review and adjustment. Refer to Section 23 05 06 – Demonstration and Owner's Instruction for HVAC Systems.

.3 The Vendor shall comply with the Engineers requests for modification of the content to suit its needs within the four (4) hour time allowance. The training agenda shall be provided four (4) weeks prior to the drive start-up, and the VFD Supplier shall schedule the timing & location of the seminar at a time and location suitable to the Engineer.

1.13 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.14 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 SECTION INCLUDES:

.1 Vendor Requirements – Service and Support

.2 General VFD Requirements

.3 Environmental Capabilities

.4 Input Power

.5 Output Power

.6 Equipment Protection

.7 Approved Filter Manufacturers

.8 Integrated VFD Equipment Enclosure

.9 BACnet

.10 PID Control

.11 Control and Operational Features

.12 Drive Control (Hand operation)

.13 Drive Controls (Auto Operation)

.14 Isolated Bypass Operation

.15 Drive Parameter Settings

.16 Diagnostics

.17 Drives Connected to Emergency Power System

.18 Wiring and Identification

2.2 VENDOR REQUIREMENTS – SERVICE AND SUPPORT

.1 The drive vendor must provide a factory-trained sales force locally available for applications assistance and to answer maintenance questions.

.2 The vendor must have a distributor organization, which locally stocks standard drives, modification kits, and spare parts.

.3 The vendor must have factory-trained service representatives within the local Lethbridge area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.

.4 Vendor must provide regularly scheduled maintenance and training schools in Canada on the equipment supplied

2.3 GENERAL VFD REQURIEMENTS

.1 All units shall be ULc or CSA approved.

.2 VFD unit shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE, NEMA, and the Canadian Electrical Code.

.3 Unless otherwise noted, all horsepower/kW ratings are to be based on a Variable Torque load.

.4 VFD shall be provided with a CSA (NEMA) Type 1 enclosure.

.5 The VFD shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the applicable schedules and indicated on the drawings.

.6 The VFDs shall have a current rating at least 10% in excess of the motor full load amp rating. When subject to the range of ambient conditions, the VFD to be capable of delivering 110% of rated output current for up to one minute for variable torque loads

.7 The VFD shall have a fixed bridge type converter (PWM) utilizing Insulated Gate Bipolar Transistor (IGBT) technology.

.8 VFD operation to be fully digital with microprocessor control of frequency, voltage, and current.

.9 Efficiency of VFD controller shall not be less than 97.5% at 60 Hz output at 100% rated load.

2.4 ENVIRONMENTAL CAPABILITIES

.1 The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:

.1 Ambient temperature: 0° to 40°C (32°F to 105°F)

.2 Humidity: 5 to 95% (non-condensing)

.3 Vibration: up to 0.5 G

.4 Altitude: 0 to 1200m (0 ft to 3940 ft); For altitudes above 1200m (3960 ft), the equipment must be properly de-rated such that the higher altitude rating is greater than the required output.

.5 The VFD unit may require fan-assisted cooling to ensure adequate heat dissipation. Such a system shall be installed in a manner that does not degrade the enclosure rating. Provide alarm status and shut-down for the VFD, on excessive temperature rise in the enclosure, for VFDs that utilize forced air fans for enclosure cooling.

2.5 INPUT POWER

.1 Input voltage shall be as indicated on motor schedules and drawings, line voltage variation (±10%), 3 phase, 60 Hz, grounded power supply without high or low line tripping. Confirm voltage before ordering.

.2 The VFD must be capable of operating under the following conditions without high or low line tripping: 3 phase, 60Hz, alternating current, grounded power supply, line voltage as shown (240,480, 600) ±10%. Speed stability shall be ±1%.

.3 Permit power line interruptions for high inertia loads such as fans and centrifuges for at least 2.0 seconds without the VFD shutting down on a fault providing an extended power loss ride-through. If the drive trips on undervoltage, the drive will activate the Automatic Restart. See “Rotating Start” clause 2.13.17.

.4 The VFD shall present a displacement power factor of 0.98 or better to the AC line over 10% to 100% speed range. Full load effective power factor shall be 96% or better.

.5 The VFD must operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 5% total harmonic voltage distortion and communication notches up to 36,500 volt microseconds.

.6 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:

.1 Line surges of up to 115% of rated voltage for up to 10 cycles. Based on 347/600 Volt systems.

.2 Line voltage sags down to 85% of rated voltage of up to 1 second duration.

.7 Provide a 5% impedance line reactor at in the drive input to protect electronic components from transient voltage conditions and to reduce harmonic current distortion.

.8 The VFD must not be sensitive to supplied power that has one phase grounded (Delta – with balanced voltages) or referenced to earth ground (Wye).

.9 The VFD must not be sensitive to incoming phase sequence.

.10 VFDs shall be of the 6-pulse PWM- type complete with an external AC line reactor to reduce harmonic current distortion.

2.6 OUTPUT POWER

.1 The VFD shall produce a 3 phase output for motor loads.

.2 Pulse-Width Modulating (PWM) circuitry must consist of a full wave diode bridge converter to convert incoming fixed voltage and frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall incorporate a microprocessor to handle all Logic functions as well as the complex, sine-coded PWM generating algorithms that control output stage switching.

.3 Generate the inverter output by IGBT power transistors only.

.4 The VFD output waveform to be the PWM or Vector type waveform producing smooth torque at low frequencies and low motor current harmonics.

.5 Harmonic loading shall not exceed the maximums acceptable for motor operation with a service factor of 1.0.

.6 The VFD output voltage shall be user-adjustable to deliver voltage from 0 V to full voltage at 60 Hz.

.7 The VFD shall be provided with user-adjustable settings to provide a frequency range of 0 to 120 Hz.

.8 Unless otherwise specified, the VFD output voltage to be adjustable from 0 to full voltage reaching full voltage at 60 Hz.

.9 Provide selectable constant V/Hz ratio PWM or variable V/Hz for Variable Torque loads.

.10 The VFD must maintain capability for 100% of rated output current continuously, regardless of change in ambient conditions throughout its listed ambient conditions range.

.11 PWM carrier frequency shall be user-selectable.

.12 Manufacturer to indicate, at time of tender, the anticipated levels of electrical noise and heat generated. In any case, the Audible noise levels to be less than 85 dbA at 1 m out from any point on the VFD cabinet under normal operating condition, with the drive at full load.

.13 Radio Frequency Interference (RFI) must be limited to levels specified in applicable standards. Equipment must be designed that use of radio communication equipment adjacent to VFD units is permissible. In addition, the VFD must not be susceptible to interference from radio equipment operated adjacent to it.

2.7 EQUIPMENT PROTECTION

.1 Protective devices to be incorporated are:

.1 Three-pole fused disconnect switch to provide over-current protection with fuses rated at not more than 150% of drive input current rating, except if the VFD is specifically marked with a recommended rating for its over-current protection, then the VFD marking shall take precedence.

.2 The operation of the disconnect switch shall be interlocked with the VFD enclosure door. It shall not be possible to open the door without the disconnect being in the open position. A manual means to defeat this interlock for maintenance purposes shall be included, and the external operator handle for the switch must have lock-out capability.

.3 The symmetrical short-circuit interrupting rating shall be verified for every installation, and be coordinated with the VFDs electronic protection circuits. VFD supplier is responsible to obtain SSCIR information from the designer or design documents for the VFDs being constructed for the project.

.4 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.

.5 Ground fault protection.

.6 Over-voltage/over-current DC bus monitor/protection.

.7 Under-voltage protection, 85% of rated input voltage.

.8 Loss of phase and phase unbalance protection.

.9 Inverter over-temperature protection.

.10 Motor overload protection, adjustable 80 to 115% of FLA of motor.

.11 Where bypass contactors are utilized or where the VFD serves several motors, provide external dial adjustable motor overload protection relays with inherent single-phase protection. The current range of the overload block shall be selected to place the full-load current of the motor at approximately the centre of the dial scale for the supplied overload relay.

.2 Include provision for adequate grounding within the equipment in addition to that provided to safeguard against electrostatic discharge damage.

2.8 APPROVED FILTER MANUFACTURERS

.1 All applications with non-VFD or VFD rated motors shall require output dv/dt filters. The following manufacturers of filters are acceptable.

.1 TCI

.2 MTE

2.9 INTEGRATED VFD EQUIPMENT ENCLOSURE

.1 The integrated VFD assembly, including all components shall be provided as a ventilated CSA (NEMA) Type 1 enclosure, with a hinged, gasketed door and a drip-shield constructed to project over the door and sized to protect all ventilation openings in the top of the enclosure (if any) from dripping water. It shall be suitable for wall or free-standing installation.

.2 Drives rated above 100HP shall be constructed as specified above, but shall be housed in CSA (NEMA) Type 12 enclosures with forced air cooling and with filters on all air inlet openings.

.3 Supply full-length painted 100mm steel channels for floor-mounted VFD enclosures.

.4 Where house-keeping pads are provided, the channel bases are not required. Where a drive is placed on top of a housekeeping pad, base construction shall be such that the door of the VFD will not drag on the house-keeping pad.

.5 Forced air cooled enclosures shall have filters on all air inlet openings.

.6 The backspan to be galvanized metal, non-painted, 16 gauge for EMC bonding requirements. Provide a minimum of 2 lugs for bonding conductors (sized per CEC). Lugs shall be bolted to the galvanized metal back-pan.

.7 Door shall be grounded with multi-conductor or braided ground strap connecting the door to the grounding system in the enclosure interior.

2.10 BACNET

.1 The VFD shall communicate with a building management system (BMS) network by digital communication using the BACnet MSTP protocol (ANSI/ASHRAE Standard 135-2016) over EIA-485.

2.11 PID CONTROL

.1 Provide process controller circuitry incorporating a PID algorithm to control the frequency output of the VFD.

.2 Input for the process controller shall be one of the analog input signals specified below (clause 2.13.1).

.3 Set-point shall be reset, as selectable parameter, either by using the digital communication network or by using the second analog input signal.

2.12 CONTROL AND OPERATIONAL FEATURES

.1 Provide two analog inputs that are both capable of receiving an input signal, user-selectable as either 4-20 mA or 0-10 Vdc. Provide individual optically isolated inputs for each analog signal.

.2 Process Signal Inverter: Provide programmable control to allow speed of drive to vary inversely with input analog signal.

.3 Provide two analog outputs, individually isolated, either 0-10 Vdc or 4-20 mA, which can be programmed to be proportional to any two of the following:

.1 Output frequency

.2 Output power

.3 Output current

.4 Provide input for external switch to be used as a proof-of-open interlock for associated damper or valve.

.5 Provide a dry contact (output) for interlocking external devices such as signal to open a damper or valve of associated the equipment.

.6 Provide dry-contact output to signal VFD fault.

.7 The VFD shall be capable of operating with its output open-circuited (no motor connected), with no fault or damage, for start-up and testing purposes. The drive must be capable of running without a motor connected.

.8 All VFD set-up operations and adjustments to be digital and stored in a non-volatile memory (EEPROM).

.9 Local communications port: Provide a local interface to upload, download, and read drive parameter settings, through the use of a notebook computer. Include Windows based software for computer on CD-ROM(s) with all associated operating instructions. Software information shall be provided with the O&M manuals.

.10 Provide offset and gain programmable functions to set operating range.

.11 The VFD shall employ a programmable rate of acceleration and deceleration, either linear or S-curve. The VFD shall “coast” to a stop or new lower speed, if selected by the user.

.12 Speed Droop: Provide a speed droop feature that reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient overload is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

.13 Speed Profile: Provide individual adjustable settings for start, stop, slope, and minimum and maximum speed points.

.14 Bumpless speed transfer: Provide a smooth speed transfer from remote control to local control and vise-versa, without setting the motor to zero speed.

.15 Automatic Reset and Restart: Provide automatic restart of rotating equipment following power outage. Provide programmable automatic reset / restart after any individual trip condition resulting from over-current, over voltage, under voltage, or over-temperature.

.16 Re-start attempt limit: for safety, the drive shall shut down and require manual reset if the automatic reset function is not successful within a maximum of three attempts within a user-programmed time period.

.17 Pick up a spinning-load (Rotating Start): The VFD shall be user-programmable for rotating re-start, enabling the VFD to start into a rotating motor, regardless of direction, without tripping offline and without setting the motor to zero speed. The VFD shall start at the speed the motor is rotating and then accelerate the motor according to the speed reference signal. After the VFD trips due to under-voltage and whenever any momentary power loss occurs, the drive must activate an automatic restart mode (re-initiate and re-start) without waiting for the rotating equipment to stop, and without operator intervention.

.18 Torque Compensation: Provide user-programmable automatic boost in torque to handle impulse loads or demands for fast acceleration by momentarily increasing the output volt / hertz ratio. When selected, the function to be operative at all speeds even under overload conditions, and eliminates the motor speed droop that would otherwise occur.

.19 Provide adjustable skip frequencies with programmable bandwidth to avoid operation in a resonant speed area. Provide a minimum of 3 such frequency selections.

2.13 DRIVE CONTROL (HAND OPERATION)

.1 Provide an operator station on the drive door complete with the following features as a minimum. The following applies to a VFD with Bypass capability. Adjust requirements as applicable for VFDs without a Bypass starter.

  .1 Control Switches

  .2 Selector switch No. 1: "HAND-OFF-AUTO" operation.

  .3 Selector switch No. 2: "VFD ENABLED -OFF -BYPASS ENABLED" operation.

  .4 Potentiometer for local speed adjustment in VFD mode.

.2 Pilot lights on door

  .1 Input Power: "ON" pilot light

  .2 VFD Status: "STOP" and "RUN" indication

2.14 DRIVE CONTROLS (AUTO OPERATION)

.1 The VFD to accept an isolated output signal via the Building Management System to stop and start the drive.

.2 The VFD to have the capability to interlock of up to 3 NIC external alarm interlocks to shut down the VFD and provide status of the trip.

.3 The VFD to provide two (2) programmable Form C dry contact status outputs. Status of contacts to indicate:

  .1 Run

.2 Fault

.4 Controller "stop" interlock from a NC dry contact.

.5 The VFD to accept an isolated analog input speed reference of 0 to 10 VDC or 4-20 mA from the field. The 4-20 mA analog input speed reference signal shall be optically isolated. Calibration adjustments shall be provided for settings within the speed ranges specified.

2.15 ISOLATED BYPASS OPERATION (WHERE SPECIFIED ON EQUIPMENT SCHEDULE(S))

.1 Provide for an automatically controlled three-contactor isolated bypass control, integral to the VFD enclosure.

.2 Bypass starters to be solid-state reduced voltage type above xxxx HP. Note: Indicate HP

.3 Coordinate over-current protection rating for the drive and bypass starter to protect both devices in either mode of operation.

.4 Provide a thermal overload relay sized to protect the motor for either mode of operation.

.5 Provide a three position "HAND-OFF-AUTO" and a “VFD-OFF-BYPASS” selector switch

.1 VFD MODE:

.1 Selector switch in "HAND" position: speed controlled by the potentiometer.

.2 Selector switch in "OFF" position: Motor cannot be started.

.3 Selector switch in "AUTO" position: VFD operates by remote start / stop command, the speed controlled by the isolated 0-10Vdc or 4 -20 mA signal.

.2 BYPASS MODE:

.1 Selector switch "HAND" position

.2 Selector switch "OFF" position prevents motor from operating.

.3 Selector switch "AUTO" position allows motor to start by remote start / stop command.

.4 All Interlocks are in the circuit for all modes of operation.

2.16 DRIVE PARAMETER SETTINGS

.1 VFD configuring settings shall be field adjustable through the keypad and display unit or via the serial communication port.

.2 The digital keypad must allow the operator to enter exact numerical settings. A plain English user menu (rather than codes) shall be provided in software to guide parameter setting. Drive parameters shall be factory set in EEPROM and be resettable by the user through the keypad. Keypad setting shall disable parameter changes by unauthorized personnel.

2.17 DIAGNOSTICS

.1 On power-up, the VFD shall execute a self-diagnostic check. The integral programming display panel shall provide first fault indication of VFD protection functions. Fault indication to be retained if input power is lost.

.2 Provide a software graphing feature for up to eight different programmable signals at the time of a fault trip or during operation

.3 The fault log record shall be accessible via a portable computer, connected directly to VFD, as well as from readout on the keypad display on the panel door.

.4 Fault codes shall provide direction as to board level and input–output level to aid in trouble-shooting.

.5 The following faults to be displayed on the local programming panel:

.1 Over-current

.2 Short Circuit / Ground Fault

.3 Under voltage

.4 Over voltage

.5 Over temperature

.6 Power Supply Fault

.7 Motor stalled

.6 Diagnostic and indicating features:

.1 Power ON indication.

.2 All set points

.3 Percentage speed indicator.

.4 Overload indication.

.5 Short circuit indication.

.6 Ground fault indication.

.7 Over-voltage indication.

.8 Under-voltage indication.

.9 High temperature (controller).

.10 AC voltmeter (output).

.11 AC ammeter (output).

.12 Inverter ready.

.13 Inverter fault.

.14 External fault.

.15 Motor Frequency

2.18 DRIVES CONNECTED TO EMERGENCY POWER SYSTEM

.1 The VFD may be supplied from an emergency power distribution system, which is subjected to short power interruptions during test of the emergency generator system. The VFD shall continuously operate through this test mode. See “Rotating Start”, clause 2.13.17.Refer to the VFD Schedule on drawings.

2.19 WIRING AND IDENTIFICATION

.1 Control wiring shall be stranded TEW 105°C (220°F) rise.

.2 Terminal blocks for remote interface shall be Weidmueller SAK6N or approved equivalent.

.3 Provide wire markers at both ends of all control wires, Electrovert type Z or approved equivalent.

.4 Where applicable, provide lamicoid tag warning of more than one voltage and provide caution label regarding regenerative voltage that may be present on load side of output contactor.

Part 3 Execution

3.1 SECTION INCLUDES

.1 Index

.2 Installation

.3 Cabling and Grounding by Division 26

.4 Start-Up

.5 Commissioning

.6 Start-up and Commissioning Service

.7 Examination

3.2 INSTALLATION

.1 Install VFDs in accordance with the manufacturer's recommendations.

.2 Set and secure VFD assembly in place on channel bases, or on housekeeping pad as permitted elsewhere, rigid, plumb and square to building floor and wall.

.3 Protect against dust and damage during entire construction period. If filters have been soiled replace filter media at the end of the construction period. To this end VFD supplier shall ship one (1) extra set of filter media for each drive equipped with filter systems from the factory. If unused these shall be turned over to the Owner for future replacements.

.4 After connections have been made, vacuum exterior and touch-up any damaged paint. Vacuum clean the interior.

.5 Mechanical Trade shall be responsible for the supply and complete commissioning of each variable speed drive to the satisfaction of Consultant and Owners Commissioning Forces. Division supplying the drive shall allow for factory representative to completely calibrate all drive circuits after installation on site. Final drive settings (the final "as left" state) shall be as-built and changes from earlier configurations shall be dated and signed. Copies of the data shall be provided both in the drives and the O&M Manuals for the Project.

.6 The VFD vendor shall include for the necessary engineering, programming and on-site commissioning related to the BACnet interface. Include for on-site coordination and check out with the BMS contractor, including point-to-point verification for those points utilized in the BMS programming and graphics. This shall include for points either hardwired as discrete points or points brought in through the BACnet interface.

.7 Prohibited locations for VFD installations are where greater than normal dust accumulations occur and where higher than normal ambient temperatures or poor ventilation exists. (Some examples are: near steam stations, steam converters, condensate tanks, generators, or where passive or forced ventilation systems will bring dust into the space).

.8 Conduit and Cable entries into VFDs shall be made through either the bottom or the side of the unit. Top entry into VFDs by conduits or cables is not permitted.

3.3 CABLING AND GROUNDING BY DIVISION 26

.1 Coordinate with the Electrical Trade to ensure the supply and installation of cables and electrical connections to the VFDs are correct.

.2 Division 26 will provide separate conduits and or cables for VFD input and output power:

  .1 If the VFD is not preinstalled and pre-wired as a part of a packaged mechanical equipment assembly unit, supply, install, and connect Alcatel Drive Rx Cable (or equal) from VFD to designated motor load for motors separated by more than 10 meters of cable length from the VFD. For motors installed at 10m or less from the unit, the use of standard building wire inside of steel conduit and terminal sections of seal tight flex is deemed acceptable.

.3 Supply, install, and connect the feeders with adequately sized grounding / bonding conductors in conduit (or cable) as indicated on the project drawings and / or in the specifications from motor control centre to VFD.

.4 Supply and install a ground conductor in each control conduit with the signal and data control cables from Building Management System (BMS) to each VFD.

.5 If a local disconnect is required (by either the engineered design or by Canadian Electrical Code) near the motor, the operating mechanism of the disconnecting means shall be so constructed that an auxiliary NO-NC contact will change state when the Switch is operated. Control wiring shall be installed between the disconnect switch and the VFD to enable the VFD to determine if the disconnect switch is open or closed. VFD safeties shall be enabled when the motor is disconnected on the load side of the VFD.

.6 Local motor disconnects or isolating switches for motors driven by VFDs shall be identified with a separate lamicoid nameplate located as close as practicable to the operating handle of the field (local) disconnecting means. Tag color shall be Orange Face & White Core. The tag shall contain the following wording: "WARNING: Do not open while motor is rotating! Severe damage to VFD will occur! Shut down VFD and only then, open this Switch for Safety. Close switch prior to restarting VFD!". Warning nameplates shall be mechanically fastened to the disconnect switch.

.7 Torque all conductors with calibrated torque wrench. Terminations to be checked, including but not limited to, power, line, load, ground, and control. Terminations shall be torqued to the manufacturer's recommendation.

3.4 START-UP

.1 The mechanical trade will be responsible to coordinate the installation, testing, and start-up (prior to commissioning commencement) with other parties participating in the start-up activities.

.2 Start-up to be accomplished as detailed in following example Vendor Start-up Requirements. These shall be considered the minimum general requirements and shall be in addition to the manufacturer's recommended start-up. Where the Vendor or assigned start-up agency believes any requirement to be harmful to the drive or would invalidate warranty, the item(s) of concern shall be identified in writing to the attention of the Engineer.

3.5 COMMISSIONING BY VENDOR

.1 The vendor shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory-certified service technician who is experienced in start-up and repair services. Service technician shall be a certified journeyman electrician. Sales personnel and other agents who are not factory certified technicians for drive repair shall not be acceptable as commissioning agents.

.2 The Contractor, in conjunction with the mechanical trade, is responsible to schedule start up and commissioning. Scheduling of Commissioning Activities will provide a minimum 5 working days notice to the vendor and Owners commissioning team prior to each separate commissioning activity.

.3 Complete vendors commissioning consistent with factory start up forms. These shall be considered the minimum requirements for Vendors Commissioning. Where the Vendor or Owners Commissioning Team believes any commissioning requirement to be harmful to the drive or would invalidate warranty the item(s) of concern shall be identified in writing to the attention of the Engineer.

.4 Submit the following written documentation:

  .1 Verification of proper wire terminations and conduit runs to and from the VFD.

.2 Completion of vendors Start-up and Commissioning Form.

.3 Verify BMS calibration.

.4 Confirm Set-up and tuning of control loop resident in the VFD.

.5 Confirm that commissioning procedures have been completed.

3.6 OWNERS START-UP AND COMMISSIONING PROCEDURE

.1 Each drive will be subject to an Owners start-up and commissioning procedure (hereafter referred to as the Owners Commissioning Team), that will include the Owner (or Owners agent), mechanical trade, electrical trade, and the VFD Vendor. Refer to the sample Owners Commissioning Team check sheet, Article 3.9 that may be utilized by the Owner.

.2 Provide the Owners Start-up &Commissioning Team with 7 days' notice of VFD start-up. They may elect to witness the vendor's start-up. Vendor's start-up services shall include checking and verifying proper installation and operation of the VFD, its installed options, and its interface to the building management system as a minimum.

.3 Owners Start-Up and Commissioning Team will verify the programming of the VFD and will provide a written copy of the settings to the Engineer.

.4 Owners Start-Up and Commissioning Team will identify critical frequencies that may occur throughout the operating curve of the equipment. Vendor shall program the drive to run through the critical frequencies that have been identified.

3.7 EXAMINATION

.1 The Contractor is to verify that the jobsite conditions for installation meet the factory recommendations and code required conditions for the VFD installation prior to start-up. These shall include as a minimum:

.1 Clearance spacing.

.2 Compliance with environmental ratings of the VFD system.

.3 Separate conduit installation of the input wiring, the motor wiring, and control wiring. At no time does any of this wiring run in parallel with each other.

.4 All power and control wiring is complete.

.5 Site has been suitably cleaned.

.2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD system shall not be operated while the unit is covered.

3.8 VFD SCHEDULE

.1 Supply, install, start up, and commission VFD's serving motors on mechanical equipment as scheduled on drawings:

3.9 OWNERS COMMISSIONING TEAM CHECK SHEETS (SAMPLE):

VFD Information					
Make				Model Number	
Serial Number				Service Area	
Volts/Phase				Function	
Motor HP		Motor Amps		Drive Max Amps	
Comments:					

Associated Checklists					
Cooling Tower	☐	Air Handling Unit	☐	Other	☐
Pump	☐	Exhaust Fan	☐	Other	☐
Comments:					

Requested documentation submitted	Rec'd	Comments
Manufacturer's cut sheets	☐	
Performance data (pump curves, fan curves, coil data, etc.)	☐	
Installation and startup manual and plan	☐	
O&M manuals	☐	
Factory test results	☐	
Sequences and control strategies	☐	
Warranty Certificate	☐	
Comments:		

Installation Checks			
Check if Acceptable; Provide comment if unacceptable	A	NA	Comment
General			
Installation per manufacturer's requirements	☐	☐	
Permanent label affixed and UL stamp approved	☐	☐	
Drive location not subject to excessive moisture or dirt	☐	☐	
Drive location not subject to excessive temperatures	☐	☐	
Appropriate Volts vs. Hz curve is being used	☐	☐	
Drive independently mounted	☐	☐	
Cooling air flow path clean and unobstructed	☐	☐	
VFD interlocked to control system	☐	☐	
Unit is programmed with full written programming record on site	☐	☐	
Accel time set to ___________ and Decel time set to ___________	☐	☐	
Coordinated with BMS for all interface ranges and signal isolation	☐	☐	
Restart on Power Failure parameter set to auto	☐	☐	
Drive min and max speed set to _______ Hz min and 60 Hz max	☐	☐	
Security settings set per owner direction and Password documented for owner	☐	☐	
Drive response to loss of signal set to ___________	☐	☐	
Output pulse resolution set to __________ MHz. (This is coordinated with the application to minimize audible noise and coordinated with driven bearing allowances.)	☐	☐	
Input of motor FLA represents 100% to 105% of motor FLA rating	☐	☐	
Upper frequency limit set at 100%, unless explained otherwise	☐	☐	
Electrical and Controls			
Power disconnect is located within site of the unit it controls and labeled	☐	☐	
All electric connections tight	☐	☐	
Grounding installed for components and unit	☐	☐	
Safeties installed and operational	☐	☐	

Installation Checks			
Check if Acceptable; Provide comment if unacceptable	A	NA	Comment
Overload breakers installed and correct size	☐	☐	
All control devices and wiring complete	☐	☐	
Control system interlocks connected and functional	☐	☐	
Installation per manufacturer's instructions	☐	☐	
Rotates in the correct direction (for VFD, check Inverter and BYPASS modes)	☐	☐	
Checked the input voltage with drive disconnected	☐	☐	

Operational Checks			
Check if Acceptable; Provide comment if unacceptable		NA	Comment
Operation checked in HAND, OFF, and AUTO. As applicable operation also checked in BYPASS. Where applicable, ensure safeties are active in all modes	☐	☐	
Specified point-to-point checks have been completed and documentation record submitted for this system	☐	☐	
Start-up complete	☐	☐	

3.10 VENDORS SAMPLE START-UP SHEET

VFD Tag:			
Pkg. S/N:			
Date:			
Commissioning Agent		Phone	
Service Technician		Fax	
		Email	
Customer:		Phone:	
Address:		Fax:	
		Email:	
Project:		Building:	
Address:			
Site Contact:		Phone:	
Name:		Fax:	
		Email:	

NAMEPLATE INFORMATION									
Package Type:			VFD Tag:			Location:			
Package Model:			S/N:			Application:			
VFD	Model:		HP (CT)		HP (VT)		Voltage:		
	S/N:		FLA (CT)		FLA (VT)		Logic #		
	MFG #		Date Code						
Motor	Make:				Voltage:		HP:		

	Model:				RPM:		FLA:	
	Insulation Class:		Frame		SF:		Type:	
	Ambient Temp:		Duty Cycle:		Efficiency:		Frequency:	

PRE POWER-UP CHECKS								
Line Reactor	Make:			Model:		Connection :		
Load Reactor	Make:			Model:		Connection :		
Filters	Outpu t:			RFI:		Arrestor:		
Environment		Temp. with -10 to 40C (14 to 104F)					If No:	
		Humidity OK?					If No:	
		Adequate Ventilation?					If No:	
		Drip Shield?					If No:	
		Clean?					If No:	

Wiring :	Input Power	Complete ?			Separate Conduit?		Proper Size?		
	Output Power				Separate Conduit?		Proper Size?		
	AC Control				Separate Conduit?		Proper Size?		
	DC Control				Separate Conduit?		Proper Size?		
	Grounding						Proper Size?		
Fuses	Input Power:			Control XFMR Primary		Control XFMR Secondary:			

Motor Megger Test								

POWERED CHECKS							
Power Supply	Vab:	V	Vac:	V	Vbc:	V	
	+/- 10% ?		V a-b-c Balanced with 3% ?				
	DC Bus:		Within 5% of input? (AC x 1.414)				
Motor Rotation	VFD:		Bypass		Free Run Stop Time	sec	
Motor Current (in amps)	VFD	@ 60 Hz:	A	@ 45 Hz	A		
		@ 30 Hz:	A	@ 15 Hz:	A		
		Current within specification at all frequency ranges?					
	Bypass	A	Current within specification?				

Signal	Input	Type	OK?	Output	Type	OK?
	Frequency Reference:			Frequency Feedback:		
	Run:			Current Feedback:		
	External Interlocks:			Run Status:		
	Run Permissive:			Fault Status:		
Operator	Bypass Module Type:		Key Pad Type:		Speed Pot	
Switches	VFD-Off-Bypass		Hand-Off-Auto		(Other)	

Lights	Power:		Hand:		Auto:		Run:	
	VFD:		Bypass:		At Speed:		Fault:	

		Keypad Lit		Ext. Fault:	

AUXILLIARY ITEMS / OPTIONS (e.g. PUMPS STARTERS; PAN HEATERS)			
Option Type #1:		Option Type #2:	
Voltage:		Voltage:	
HP / kW:		HP / kW:	
Fuses / Size:		Fuses / Size:	
Sel. Sw.		Sel. Sw.	
Pilot Light(s)		Pilot Light(s)	
Functions per Dwg?		Functions per Dwg?	
Measure Amps:		Measure Amps:	
Other Comments:		Other Comments:	

External PID Controller	Parameter Settings per Attached			
Network Communications				
Network Type (e.g. N2, FLN, BACnet)		Model / Type of Interface:		
		Address:		

General			
Parameters recorded and attached?		If no, why?	
Parameters saved to laptop?		File Name:	
Parameters uploaded to keypad?			
Manual in the package?		If no, why?	
Wiring diagram in the package?		If no, why?	
“As Commissioned” marked up dwgs attached?		If no, why?	
Other instruction manuals in the package?		If no, why?	

Any changes to the package?		If yes, then notify us with the changes	
Commissioning Completed by (print):			
Sign:			
Commissioning Completion Date:			

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Flexible pipe connections

.2 Expansion joints and compensators

.3 Pipe loops, offsets, and swing joints

1.2 REFERENCE STANDARDS

.1 American Society for Testing and Materials International, (ASTM)

.1	ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
.2	ASTM A105/A105M	Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 QUALITY ASSURANCE

.1 Conform to Standards of "Expansion Joint Manufacturers Association" and manufacturer's recommendations.

.2 Provide inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

1.4 GENERAL REQUIREMENTS

.1 Select all expansion compensators for the pressure and temperature to suit the service. Base axial traverse on -17.8°C (0°F), ambient to corresponding fluid temperature plus 25% safety factor.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

- .1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

- .2 Submit shop drawings that include, at a minimum, the following information:
  - .1 Manufacturer, model number, line contents, pressure and temperature rating.

.2 Movement handled, axial, lateral, angular and the amounts of each.

.3 Nominal size and dimensions including details of construction and assembly.

1.6 CLOSEOUT SUBMITTALS

.1 Provide maintenance and operation data in accordance with Section 01 78 00 – Closeout Submittals.

.2 Product Data:

.1 Refer to shop drawing requirements above.

.3 Operation and Maintenance Manuals:

.1 Data to include: Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 FLEXIBLE PIPE CONNECTORS

.1 Flexible Rubber Spools: Neoprene twin sphere connector of molded multiple plys of nylon tire cord fabric and neoprene, rated for 1035 kPa (150 psi) at 120°C (250°F). Union end connections for sizes 50mm (2”) and under; floating galvanized ductile iron flanges for sizes over 50mm (2”).

.2 Spherical Rubber Spools: Neoprene single sphere elbow connector, construction and service rating same as 2.2.1 above.

.3 Braided Spools for Copper Piping: Stainless steel inner core and braid brazed to copper tube ends, suitable for 1035 kPa (150 psi) at 120°C (250°F).

.4 Braided Spools for Steel Piping: Stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50m (2”) diameter, flanged for 65mm (2½”) diameter.

2.2 EXPANSION JOINTS

.1 Copper piping: Laminated stainless steel bellows brazed to copper tube ends, internal guide, stainless steel external shroud; suitable for 1035 kPa (150 psi) at 260°C (500°F).

.2 Steel piping up to 100mm (4”): Laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50mm (2”), flanged ends for sizes 65mm (2½”) and over; internal guide and carbon steel shroud suitable for 1035 kPa (150 psi) at 260°C (500°F).

.3 Steel piping 100mm (4”) and over: Guided externally pressurized laminated stainless steel bellows, flanged ends, internal guide tube and ring, external shroud and guide ring suitable for 1035 kPa (150 psi) at 260°C (500°F).

2.3 PIPE GUIDES

.1 4 finger "spider" inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guides to accommodate specified thickness of insulation; vapor barriers, jackets to remain uninterrupted.

.4 Guide length to be minimum 300mm (12”).

2.4 ANCHORS

.1 Anchors shall securely attach piping to structural members. Size the anchors to accommodate the forces due to the pipe expansion and weight.

.2 Construct anchors from steel plate and channel. Where bolts secure anchor to the structure, weld the bolts to the plate.

.3 Arrange anchors so that bolts are in shear, not in tension.

.4 Provide anchors on both sides of expansion devices, as indicated on the drawings, and as required to control the flexing of the piping system.

2.5 EXPANSION LOOPS

.1 Provide expansion loops as required. The three legs of the expansion loop shall be equal.

.2 Cold springing of the expansion loop up to 50% of the expansion considered is permitted.

Part 3 Execution

3.1 APPLICATION

.1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation and where indicated on the drawing.

.2 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide expansion joints where indicated or required.

.3 Provide pipe guides as required to ensure correct pipe alignment for expansion joints. Minimum two guides on each side of expansion joints.

3.2 INSTALLATION

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

.2 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

.3 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.4 Install flexible connectors and expansion joints in accordance with manufacturer's instructions.

.5 Do not compress or expand connector during installation.

.6 Make adequate allowance for expansion and contraction of piping using expansion joints, flexible connections, pipe loops or offsets as indicated and as required. Properly guide and anchor all piping and install expansion joints in strict accordance with manufacturer’s instructions and ASHRAE Handbooks.

.7 Provide for expansion where pipe temperature is higher than ambient and where the straight runs are over 20 meters (65 feet) or as indicated or where piping crosses and will be affected by a building expansion joint.

.8 Weld or clamp anchors to the pipe and fasten to the building structure or embed in concrete pier such that all forces and thrusts acting at the anchor point are restrained. Submit proposed method of anchoring for approval. Also refer to ANSI B31.1 for methods of fabricating anchors and guides.

.9 Anchor horizontal runs of brass and copper pipe and tubing over 15.3 meters (50 feet) in length to wall or floor construction. Locate anchors near the mid-points of the runs so as to force the expansion equally to the ends or in a direction where expansion can take place without excessive strain.

.10 Install pipe guides per manufacturer’s instructions and recommendations or place first guide maximum of four pipe diameters and second guide maximum of fourteen pipe diameters away from expansion joints on each side.

.11 All pipe guides to be securely anchored to building structure. Obtain approval for anchoring method.

3.3 PIPE CLEANING AND START-UP

.1 In accordance with Section 23 08 16 - Cleaning and Start-up of Mechanical Piping Systems.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Common Work Results for HVAC — Section 23 05 00

.2 Domestic Water Piping — Section 22 11 16

.3 Facility Natural Gas Piping — Section 23 11 23

.4 Steam and Condensate Piping — Section 23 22 13

1.2 REFERENCE STANDARDS

.1 Alberta Boilers Safety Association (ABSA)

.2 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

- .1 ANSI/ASME B31.1-2018 — Power Piping.
- .2 ANSI/ASME B31.3-2016 — Process Piping.
- .3 ANSI/ASME B31.9-2017 — Building Services Piping
- .4 ANSI/ASME Boiler and Pressure Vessel Code-2017
  - .1 Section I — Power Boilers.
  - .2 Section V — Nondestructive Examination.
  - .3 Section IX — Welding and Brazing Qualifications.

.3 American National Standards Institute/American Water Works Association (ANSI/AWWA)

- .1 ANSI/AWWA C206-2017 — Field Welding of Steel Water Pipe.

.4 American Welding Society (AWS)

- .1 AWS C1.1M/C1.1-2012 — Recommended Practices for Resistance Welding.
- .2 AWS Z49.1-2012 — Safety in Welding, Cutting and Allied Process.
- .3 AWS W1-2015 — Welding Inspection Handbook.

.5 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-48.2 — Spot Radiography of Welded Butt Joints in Ferrous Materials

.6 Canadian Standards Association (CSA International)

- .1 CSA W47.2-11 (R2015) — Certification of Companies for Fusion Welding of Aluminum.

.2 CSA W48-18 — Filler Metals and Allied Materials for Metal Arc Welding.

.2 CSA B51-14 — Boiler, Pressure Vessel and Pressure Piping Code.

.3 CSA-W117.2-12 (R2017) — Safety in Welding, Cutting and Allied Processes.

.4 CSA W178.1-18 — Certification of Welding Inspection Organizations.

.5 CSA W178.2-18 — Certification of Welding Inspectors.

.6 CAN/CSA-Z662-15 — Oil and Gas Pipeline Systems

1.3 QUALITY ASSURANCE

.1 Qualifications:

.3 Welders:

.1 Welding qualifications in accordance with CSA B51.

.2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.

.3 Submit welder's qualifications to Consultant.

.4 Each welder to possess identification symbol issued by authority having jurisdiction.

.5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.

.6 Use pressure welders for work on systems containing pressure in excess of 103.4 kPa (15 psig).

.4 Inspectors:

.1 Inspectors qualified to CSA W178.2.

.5 Certifications:

.1 Registration of welding procedures in accordance with CSA B51 and provincial regulations.

.2 Copy of welding procedures available for inspection.

.3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – - Submittal Procedures.

1.5 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

Part 3 Execution

3.1 APPLICATION

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

3.2 QUALITY OF WORK

.1 Welding: in accordance with ANSI/ASME B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Division 22 or 23 and applicable requirements of provincial authority having jurisdiction.

.2 Weld in accordance with the requirements of the Provincial Boiler Inspection Branch.

.3 Welded joints shall be free of defects including: elongated slab, isolated slag, porosity, incomplete penetration, lack of fusion, burn-through, cracks, arc burn, internal concavity, hollow beads, internal undercuts, and external undercuts.

.4 Submit a statement describing welding procedures proposed for the review of the consultant before commencing work.

.5 Before proceeding with the welded joining on the entire piping system, prepare not more than ten sample joints for the on-site review by the consultant. The consultant may request the cutting out of one or more welding joints for close visual examination or x-ray test. Once the consultant has reviewed the samples, the remaining pipe welding joints shall be to the standard accepted.

3.3 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 50mm (2”) and smaller: install welding type sockets.

.2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS – GENERAL REQUIREMENTS

.1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.

.3 Examination and acceptance criteria to Category D Fluid Service as per Chapter VI, ASME B31.3 – Process Piping.

.4 Welded natural gas piping to be inspected as per the requirement of CSA B149.1 – Natural Gas and Propane Installation Code.

.5 Do not conceal welds until they have been inspected, tested and approved by inspector.

.6 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

.7 All systems to be pressured tested as noted in Section 2e 05 00 – Common Work Results for HVAC.

.8 Submit all certified test reports to the consultant.

3.5 DEFECTS CAUSING REJECTION

.1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

.1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.7 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Thermometers

.2 Pressure gauges

.3 Static pressure gauges

.4 Positive displacement meters

.5 Provide meters, gauges and taps where shown on drawings and/or specified herein.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition [1971].

.2 ASME B40.100 Pressure Gauges and Gauge Attachments.

.3 ASME B40.200 Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB).

.1 CAN/CGSB-14.4 Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

.2 CAN/CGSB-14.5 Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.1 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit list of all meters, including location, service, flow and corresponding reading for flow.

.2 Submit shop drawings that include, at a minimum, the following information:

.1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.

.2 Service conditions.

.3 Full details of primary element including standard of design and construction, materials.

.4 Accuracy statements for each component at specified flow rates and other conditions.

.5 Flow, temperature or pressure ranges.

.6 Signal processor calibration data.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

.1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 – Closeout Submittals.

1.5 DELIVERY & STORAGE

.3 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 WASTE MANAGEMENT AND DISPOSAL

.4 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 THERMOMETERS

.1 Dial Thermometers: 75m (3”) diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket or flange and bushing, glass cover, adjustable pointer.

.2 Mercury Thermometer: Not allowed.

.3 Provide separable brass wells to suit pipe diameter and extensions for insulation. For duct thermometers, provide extension stems, aluminum fastening flange and extension for insulation.

.4 Thermometer range to suit service.

.5 Graduate thermometers with Fahrenheit **and** Celsius scales.

2.2 PRESSURE GAUGES

.1 100mm (4”) diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% midscale accuracy, front calibration adjustment, black figures on white background. Pressure gauges shall be liquid filled with ½% accuracy in locations subject to vibration (on pumps, air handling units, and chillers), and 1% accuracy in all other locations. Provide needle valve and syphon for steam service, pulsating damper and ball valve for water service.

.2 Provide each gauge with brass gauge cock or needle valve.

.3 Provide steam gauges with brass coil syphons.

.4 Pressure range to suit service.

2.3 PRESSURE/TEMPERATURE TAPS (PETE'S PLUGS)

.1 Fitting to allow a 3mm (12 gauge) O.D. plug-in gauge to measure temperature or pressure.

.1 Maximum pressure: 3450 kPa (500 psi)

.2 Maximum temperature: 135°C (275°F)

.2 Fitting constructed of:

.1 6mm (¼") NPT brass body with hex head screw cap and gasket.

.2 Protective screw cap to have retaining strap.

.3 Two self-closing valves constructed of nordel.

.3 Test kit including the following:

.1 One 65mm (2½") diameter pressure gauge with 3mm (12 gauge) O.D. plug-in stem.

.2 Two 45mm (1¾") diameter temperature gauges with 3mm (12 gauge) O.D. x 125m (5") plug-in stem, range 0°C to 110°C (32°F to 230°F).

.3 All above in protective carrying case with operating instructions.

.4 Installation:

.1 Install pressure/temperature taps into threaded pipe nipples welded to wall of pipe. Locate fittings in accessible spaces.

.2 Provide one pressure/temperature taps test kit.

2.4 STATIC PRESSURE GAUGES

.1 Dial Gauge: 100mm (4") dial, diaphragm actuated, suitable for positive, negative, or differential pressure measurement. Accuracy within ±2% of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined Vertical Manometer: molded plastic manometer, accuracy within ±3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips, and mounting accessories.

2.5 POSITIVE DISPLACEMENT METERS

.1 Cold Water Lines: Displacement type, magnetic drives conforming to ANSI/AWWA C700, bronze body, sealed register, stainless steel trim, impulse contractor for remote registration by control system and/or control of chemical treatment.

.2 High performance turbine meter type conforming to ANSI/AWWA C701, no lead bronze body, sealed register, stainless steel trim, impulse contactor for remoter registration by control system. Unit to be complete with strainer.

.3 Gas Lines: Provide a meter of the same type and manufacture as the utility company's meter. The gas meter shall have the ability to provide a remote readout signal to the BAS.

.4 Provide positive displacement meters where indicated on drawings.

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 THERMOMETERS – INSTALLATION

.1 Provide thermometers at the inlet and outlet side of all equipment and components which create a temperature difference for both air and water circuits.

.2 Thermometer locations are generally indicated, however, additional units may be required based on as-built conditions.

.3 Check all thermometers for accuracy and recalibrate where necessary before work is handed over.

3.3 PRESSURE GAUGES – INSTALLATION

.1 Provide pressure gauges at the inlet and outlet side of all components which create a pressure difference.

.2 Pressure gauge locations are generally indicated, however, additional units may be required based on as-built conditions.

.3 Check all pressure gauges for accuracy and recalibrate where necessary before work is handed over.

3.4 METERS, GAUGES AND FLOW MEASURING DEVICES

.1 All mechanical equipment shall be provided with instrumentation or test ports to verify critical parameters, such as capacity, pressures, temperatures and flow rates.

.2 Thermometers and pressure gauges are required on all pumps.

.3 Provide one pressure gauge per pump. Install taps before strainers and on suction and discharge of pump. Pipe to gauge with ball isolation valve on each tap.

.4 For gauges on liquid service, provide tee in piping with bronze pulsation damper and ball isolation valve.

.5 Select gauges so that normal operating point is approximately mid-point of instrument range.

.6 Install gauges between equipment and first fitting valve.

.7 Install gauges in locations and angles that are easily readable from normal sight.

.8 Provide extensions where pressure gauges or thermometers are installed through insulation.

.9 Install pressure/temperature taps into threaded pipe nipples welded to wall of pipe. Locate fittings in accessible spaces.

.10 Install positive displacement meters with isolating valves. Provide valved bypass for liquid service meters.

.11 Install flow meters in uninterrupted straight pipe, minimum 5 pipe diameters downstream and 10 pipe diameters upstream, or according to manufacturers recommendations. Minimum 3 pipe diameters lateral from any physical obstruction to insertion of meter probes.

.12 Flow measuring devices shall be capable of communication with the central building automation system.

.13 Water flow devices shall conform to the requirements of ASHRAE Standard 90.1.

.14 On pipes 65mm (2½”) and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.5 METERS AND GAUGES INSTALLATION SCHEDULE

.1 Positive Displacement Meter:

  .1 Domestic Cold Water Make-up

  .2 And where shown on drawings

.2 Flow Meters:

  .1 Steam System (Orifice Plates Only)

  .2 And where shown on drawings

.3 Pressure Gauges:

  .1 Steam Header

.2 And where shown on drawings

.4 Pressure/Temperature Taps - Pete's Plugs:

.1 Where shown on drawings

.5 Thermometers:

.1 Where shown on drawings

.6 Static Pressure Gauges:

.1 Across built-up filter banks

.2 Across unitary filter sections

.3 Across supply and return fans

.4 And where shown on drawings

3.6 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.3	Hydronic Systems: Copper	Section 23 21 13.01
.4	Hydronic Systems: Steel	Section 23 21 13.02
.5	Hydronic Piping Specialties	Section 23 21 16

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1	ANSI/ASME B1.20.1-2013	Pipe Threads, General Purpose (Inch).
.2	ANSI/ASME B16.18-2018	Cast Copper Alloy Solder Joint Pressure Fittings.

.2 ASTM International (ASTM)

.1	ASTM A276-17	Standard Specification for Stainless Steel Bars and Shapes.
.2	ASTM B62-17	Standard Specification for Composition Bronze or Ounce Metal Castings.
.3	ASTM B283-18a	Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
.4	ASTM B505/B505M-18	Standard Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1	MSS-SP-25-2018	Standard Marking System for Valves, Fittings, Flanges and Unions.
.2	MSS-SP-80-2013	Bronze Gate Globe, Angle and Check Valves.
.3	MSS-SP-110-2010	Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 QUALITY ASSURANCE

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body”

- .1 Manufacturer’s name or trademark

.2 Products to have CRN registration numbers

.3 Pressure rating

.4 Flow direction

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit detailed shop drawings clearly indicating, at a minimum, the following:

.1 Manufacturer and model

.2 Size and connection type

.3 Pressure rating

.4 Materials of construction

.5 Intended service

1.5 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size. Minimum 1.

.3 Stem packing: one for every 10 valves, each size. Minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.6 Lockshield keys: Where lockshield valves are specified, provide 10 keys of each size – malleable iron cadmium plated.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 End Connections:

.1 Connection into adjacent piping/tubing:

.1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.

.2 Copper tube systems: solder ends to ANSI/ASME B16.18.

2.2 BALL VALVES

.1 Up to 65mm (2½”):

.1 Two-piece cast bronze body, TFE seats, standard port, lever handle, separate packnut with adjustable stem packing, anti-blowout stems and stainless steel ball with vent.

.2 Valve ends shall have full depth ANSI threads or extended solder connections and be manufactured to comply with MSS SP-110.

.3 Rating: 4137 kPa (600 psi) non-shock cold working pressure (CWP)

1034 kPa (150 psi) saturated steam pressure

.4 Where piping is insulated, ball valves shall be equipped with 50mm (2") extended handles of non-thermal conductive material. Provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included.

2.3 CHECK VALVES – SILENT

.1 Up to 50mm (2”):

.1 Bronze body and disc, 316 stainless steel spring, Teflon disc seat ring, threaded ends.

.2 Valve to be manufactured in accordance with MSS SP-80.

.3 For installation on vertical lines or pump discharge.

.4 Rating: 1724 kPa (250 psi) non-shock cold working pressure (CWP)

2.4 CHECK VALVES – SWING

.1 Up to 50mm (2”):

.1 Class 150, bronze ASTM B-62 body with TFE seat disc, Y-pattern, renewable seat and disc. Valve ends may be threaded or solder-type.

.2 Valve to be manufactured in accordance with MSS SP-80.

.3 Rating: 2068 kPa (300 psi) non-shock cold working pressure (CWP)
1034 kPa (150 psi) saturated steam to 185°C (366°F)

2.5 CIRCUIT BALANCING VALVES

.1 15mm to 75mm (½” – 3”):

.1 The valve body shall be constructed out of lead free brass and shall include a ball valve constructed of 304 stainless steel, two pressure/temperature ports and an optional drain valve port.

.2 The valve shall have a reduced port design that provides velocity head recovery.

.3 The valve shall include a calibrated nameplate with a memory stop.

.4 The valve shall have either threaded or soldered end connections.

.5 The valve temperature range shall be from -20°C to 121°C (-4°F to 250°F).

.6 Rating: 2758k Pa (400 psi) working pressure (threaded end)
2068 kPa (300 psi) working pressure (soldered end)

2.6 GATE VALVES:

.1 Up to 65mm (2½”):

.1 Class 150, rising stem, union bonnet, and solid wedge. Body, bonnet and wedge are to be of bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and malleable or ductile iron handwheel. Valve ends may be threaded or solder type.

.2 Valve to be manufactured in accordance with MSS SP-80.

.3 Rating: 2068 kPa (300 psi) non-shock cold working pressure (CWP)
1034 kPa (150 psi) saturated steam to 185°C (366°F)

2.7 GLOBE & ANGLE VALVES

.1 Up to 65mm (2½”):

.1 Class 150 bronze body and bonnet to ASTM B-62. Union bonnet, stems shall be of dezincification-resistant silicon bronze (ASTM B-371) or low-zinc alloy (B-99), non-asbestos packing, TFE seat disc and malleable or ductile iron handwheel. Valve ends may be threaded or solder type.

.2 Valve to be manufactured in accordance with MSS SP-80.

.3 Rating: 2068 kPa (300 psi) non-shock cold working pressure (CWP)
1034 kPa (150 psi) saturated steam to 185°C (366°F)

2.8 VALVE OPERATORS

.1 Provide suitable hand wheels for gate, globe, angle, plug and drain valves.

Part 3 Execution

3.1 INSTALLATION

.1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.2 Align valves for easy access and identification when several service lines are installed together.

.3 Use line size throughout with the exception of control valve bypasses. Size control valve bypass valves equal to control valve.

.4 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.5 Locate valves on the main side of the unions or flanges of the equipment to allow servicing, maintenance, and equipment removal.

.6 Remove internal parts before soldering.

.7 Where butterfly valves are installed, provide lug type valves on flanged systems. Victaulic connections where approved.

.8 Provide drain valves at main shut-off valves, low points of piping, and equipment and terminal units. Size drain lines and drain valves equal to size of equipment drain connection.

.9 For pipe sizes 20mm (¾”) and over, minimum drain size to be 20mm (¾”). Provide hose thread connection cap and chain for drain valves not piped directly to floor drains or where located in ceilings or public areas.

.10 Provide a valved drain and hose connection off the bottom of all strainers.

3.2 VALVE SCHEDULE

.1 Provide valves as indicated on drawings and the following schedule:

.1 Ball Valves:

 .1 Interchangeable with gate and globe valves
 .2 Boiler drains
 .3 Branch take-offs & vertical risers (where indicated on drawings)
 .4 Heating/cooling coils
 .5 Low water cut-offs

.2 Check Valves – Silent:

 .1 Discharge of the following system pumps:

  .1 Chilled water pumps (if triple duty valves are not provided)
  .2 Condensate pumps
  .3 Feedwater pumps
  .4 Heating water pumps (if triple duty valves are not provided)

.3 Check Valves – Swing:

 .1 Backflow prevention

.4 Circuit Balancing Valves:

 .1 Branch pipe take-offs from mains and sub-mains
 .2 Heating/cooling coils
 .3 Pump discharge (if triple duty valves are not provided)

.5 Gate Valves:

 .1 Branch take-offs& vertical risers (where indicated on drawings)
 .2 Isolating Service -Isolate equipment and vertical risers
 .3 Shut-off

.6 Globe and Angle Globe Valves:

 .1 Control device
 .2 Meter bypass
 .3 Throttling service

3.3 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.3	Hydronic Systems: Copper	Section 23 21 13.01
.4	Hydronic Systems: Steel	Section 23 21 13.02
.5	Hydronic Piping Specialties	Section 23 21 16

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1	ASME B16.1-[05]	Cast Iron Pipe Flanges and Flanged Fittings.

.2 ASTM International (ASTM).

.1	ASTM A49-[01 (2006)]	Standard Specification for Heat-Treated Carbon Steel Joint Bars.
.2	ASTM A126-[04]	Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
.3	ASTM A536-[84 (2004)e1]	Standard Specification for Ductile Iron Castings.
.4	ASTM B61-[08]	Standard Specification for Steam or Valve Bronze Castings.
.5	ASTM B62-[02]	Standard Specification for Composition Bronze or Ounce Metal Castings.
.6	ASTM B85/B85M-[08]	Standard Specification for Aluminum-Alloy Die Castings.
.7	ASTM B209-[07]	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1	MSS SP-61-[03]	Pressure Testing of Steel Valves.
.2	MSS SP-70-[06]	Grey Iron Gate Valves, Flanged and Threaded Ends.
.3	MSS SP-71-[05]	Grey Iron Swing Check Valves, Flanged and Threaded Ends.
.4	MSS SP-82-[1992]	Valve Pressure Testing Methods.
.5	MSS SP-85-[2002]	Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 QUALITY ASSURANCE

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body"

.1 Manufacturer's name or trademark

.2 Products to have CRN registration numbers

.3 Pressure rating

.4 Flow direction

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit detailed shop drawings clearly indicating, at a minimum, the following:

.1 Manufacturer and model

.2 Size and connection type

.3 Pressure rating

.4 Materials of construction

.5 Intended service

1.5 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size. Minimum 1.

.3 Stem packing: one for every 10 valves, each size. Minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.6 Lockshield keys: Where lockshield valves are specified, provide 10 keys of each size – malleable iron cadmium plated.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 CHECK VALVES – SILENT

.1 65mm (2½”) and larger:

.1 Class 125 wafer or lug style, in-line, spring-actuated lift check valve. Body shall be cast iron, ASTM A-126 Class B with stainless steel spring, bronze disc plates, rubber seat. Renewable seat and disc.

.2 Valve to be manufactured in accordance with MSS SP-126.

.3 For installation on vertical lines or pump discharge.

.4 93°C (200°F) maximum working temperature

.5 Rating: 1379 kPa (200 psi) non-shock cold working pressure (CWP)

2.2 CHECK VALVES – SWING

.1 65mm (2½”) and larger:

.1 Class 125, flanged, ASTM A-126 Class B, cast iron body with bronze trim, renewable seat and disc, non-asbestos gasket.

.2 Valve to be manufactured in accordance with MSS SP-71.

.3 Maximum working temperature: 232°C (450°F) at 862 kPa (125 psi)

.4 Rating: 1379 kPa (200 psi) non-shock cold working pressure (CWP)
862 kPa (125 psi) saturated steam to 178°C (353°F)

2.3 CIRCUIT BALANCING VALVES

.1 65mm to 100mm (2½” – 4”):

.1 The valve body shall be constructed out of cast iron, and have a ball valve constructed of brass. The valve shall utilize a reduced port design that provided velocity head recovery.

.2 Valve body shall include two pressure/temperature ports and have an optional drain valve port.

.3 The valve shall utilize a calibrated nameplate with a memory stop.

.4 The valve temperature range shall be from -20°C to 121°C (-4°F to 250°F).

.5 Rating: 1207 kPa (175 psi) working pressure.

.2 100mm to 300mm (4" – 12") Circuit Balancing Valve

.1 Valve body shall be constructed out of cast iron (flanged connection) or ductile iron (grooved connection). The valve body shall include two pressure/temperature ports.

.2 The valve shall be a multi-turn globe style valve with a brass disc with a soft seat design made of EPDM.

.3 The valve shall utilize a calibrated nameplate with position indicator from 0 to 100% open. Valve shall include a memory button to allow for positioning the valve to the appropriate set position after closing.

.4 Flanged valves shall include ANSI Class 125# flanged connections. Grooved valves shall include grooved end connections.

.5 The valve temperature range shall be from -20°C to 121°C (-4°F to 250°F).

.6 Rating: 1207 kPa (175 psi) working pressure (flanged)
2068 kPa (300 psi) working pressure (grooved)

2.4 GATE VALVES

.1 75mm (3") and larger:

.1 Class 125 cast iron body, outside screw and yoke, flanged, bolted bonnet, bronze trimmed, solid wedge. Packing and gaskets to be non-asbestos.

.2 Valve to be manufactured in accordance with MSS SP-70.

.3 Maximum working temperature: 232°C (450°F) at 862 kPa (125 psi)

.4 Rating: 1379 kPa (200 psi) non-shock cold working pressure (CWP)
862 kPa (125 psi) saturated steam to 178°C (353°F)

2.5 GLOBE & ANGLE VALVES

.1 75mm (3") and larger:

.1 Class 125 cast iron body, flanged, bolted bonnet, bronze trimmed, renewable brass seat and disc. Packing and gaskets to be non-asbestos.

.2 Valve to be manufactured in accordance with MSS SP-85.

.3 Maximum working temperature: 232°C (450°F) at 862 kPa (125 psi)

.4 Rating: 1379 kPa (200 psi) non-shock cold working pressure (CWP)
862 kPa (125 psi) saturated steam to 178°C (353°F)

2.6 TRIPLE DUTY VALVES

.1 The valve shall be an angle pattern or straight pattern, non-adjustable design.

.2 The valve shall be a globe valve design and have a spring-loaded check valve design to prevent gravity circulation and backflow.

.3 The valve shall have a calibrated nameplate with multi-turn stem and shall include a rubber memory button to allow the valve to be re-balanced to its original position after shut-off or maintenance.

.4 The valve shall have a fully back-seating disc to allow the valve packing to be replaced while under pressure. The disc shall be made of brass with an EPDM rubber seat.

.5 The valve body shall be made of either cast iron or ductile iron; the valve stem shall be made of stainless steel; and the valve spring shall be made of stainless steel.

.6 The valve shall be available with either flanged end connections or grooved end connections. Flange end connections shall be designed according to ANSI Class 150 Standards.

.7 Valve models with either flange x flange or groove x flange end connections shall be rated for 1207 kPa (175 psi) maximum working pressure. Models with groove x groove end connections shall be rated for 2,068 kPa (300 psi) working pressure.

.8 The suction guide shall have a maximum temperature rating of 121°C (250°F).

.9 Rating: 1207 kPa (175 psi) maximum working pressure (flange x flange / groove x flange)
2,068 kPa (300 psi) maximum working pressure (groove x groove)

2.7 VALVE OPERATORS

.1 Provide suitable hand wheels for gate, globe, angle, plug and drain valves.

.2 Provide valves larger than 100mm (4”) located more than 2.1m (7 ft) from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5m (5 ft) above floor and hook to clips to arrange to clear walking aisles.

Part 3 Execution

3.1 INSTALLATION

.1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.2 Align valves for easy access and identification when several service lines are installed together.

.3 Use line size throughout with the exception of control valve bypasses. Size control valve bypass valves equal to control valve.

.4 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.5 Locate valves on the main side of the unions or flanges of the equipment to allow servicing, maintenance, and equipment removal.

.6 Remove internal parts before soldering.

.7 Locate valves on the main side of the unions or flanges of the equipment.

.8 Provide drain valves at main shut-off valves, low points of piping, and equipment and terminal units.

3.2 VALVE SCHEDULE

.1 Provide valves as indicated on drawings and the following schedule:

.1 Check Valves – Silent:

.1 Discharge of the following system pumps:

.1 Chilled water pumps (if triple duty valves are not provided)

.2 Condensate pumps

.3 Feedwater pumps

.4 Heating water pumps (if triple duty valves are not provided)

.2 Check Valves – Swing:

.1 Backflow prevention

.3 Circuit Balancing Valves:

.1 Branch pipe take-offs from mains and sub-mains

.2 Heating/cooling coils

.3 Pump discharge (if triple duty valves are not provided)

.4 Gate Valves:

.1 Branch take-offs& vertical risers (where indicated on drawings)

.2 Isolating Service -Isolate equipment and vertical risers

.3 Shut-off

.5 Globe and Angle Globe Valves:

.1 Control device

.2 Meter bypass

.3 Throttling service

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.

.1 Leave work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.3	Hydronic Systems: Copper	Section 23 21 13.01
.4	Hydronic Systems: Steel	Section 23 21 13.02
.5	Hydronic Piping Specialties	Section 23 21 16

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1	ASME B16	Fittings and Valves Package.
.2	ASME B16.5-[2009]	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
.3	ANSI/ASME B16.10-[2009]	Face-to-Face and End-to-End Dimensions Valves.
.4	ANSI/ASME B16.25-[2007]	Buttwelding Ends.
.5	ANSI/ASME B16.34-[2009]	Valves Flanged, Threaded and Welding End. Includes Supplement (2010).

.2 American Petroleum Institute (API)

.1	API STD 598-[2009]	Valve Inspection and Testing.

.3 ASTM International (ASTM)

.1	ASTM A49-[12]	Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
.2	ASTM A182/A182M-[11a]	Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
.3	ASTM A193/A193M-[12]	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
.4	ASTM A194/A194M-[2011]	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.

.5 ASTM A216/A216M-[08] Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.

.6 ASTM B85/B85M-[10] Standard Specification for Aluminum-Alloy Die Castings.

.4 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

.1 MSS SP-25-[2008] Standard Marking System for Valves, Fittings, Flanges and Unions.

.2 MSS SP-61-[2009] Pressure Testing of Valves.

1.3 QUALITY ASSURANCE

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body"

.1 Manufacturer's name or trademark

.2 Products to have CRN registration numbers

.3 Pressure rating

.4 Flow direction

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit detailed shop drawings clearly indicating, at a minimum, the following:

.1 Manufacturer and model

.2 Size and connection type

.3 Pressure rating

.4 Materials of construction

.5 Intended service

1.5 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size. Minimum 1.

.3 Stem packing: one for every 10 valves, each size. Minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.6 Lockshield keys: Where lockshield valves are specified, provide 10 keys of each size – malleable iron cadmium plated.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 MATERIAL

.1 Valves:

.1 To be of single manufacturer.

.2 Test valves individually.

.2 Requirements common to valves, unless specified otherwise:

.1 Pressure-temperature ratings: to ANSI B16.34.

.2 Inspections and tests: to API 598.

.3 Pressure testing: to MSS SP-61.

.4 Flanged valves:

.1 Face-to-face dimensions: to ANSI B16.10.

.2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.

.5 Butt-weld valves:

.1 End-to-end dimensions: to ANSI B16.10.

.2 End dimensions: to ANSI B16.25 bored for [standard pipe schedule].

.6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.

.7 Markings: to MSS SP-25.

.8 Identification:

.1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.

.2 Body markings: manufacturer, size, primary service rating, material symbol.

.9 CRN registration number required for all products.

2.2 GATE VALVES

.1 50mm to 300mm (2½” to 12”): Rising stem, OS&Y, solid wedge disc, flanged ends, Class 150 :

.1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.

.2 Body/bonnet joint: flat face with corrugated metallic gasket.

.3 Bonnet studs: to ASTM A193/A193M Type B7.

.4 Bonnet nuts: to ASTM A194/A194M Type 2H.

.5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.

.6 Gland packing: containing corrosion inhibitor to prevent stem pitting.

.7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.

.8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.

.9 Disc: with disc stem ring to connect to stem, guided throughout its travel.

.1 50mm to 150mm (2½” to 6”): solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.

.2 200mm (8”) and larger: carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.

.10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.

.11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.

.12 Operator: see elsewhere in this Section.

2.3 GLOBE VALVES

.1 50mm to 300mm (2½" to 12"): Rising stem, OSY, flanged ends, Class 150 :

.1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.

.2 Body/bonnet joint: flat face with corrugated metallic gasket.

.3 Bonnet studs: to ASTM A193/A193M Type B7.

.4 Bonnet nuts: to ASTM A194/A194M Type 2H.

.5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.

.6 Gland packing: containing corrosion inhibitor to prevent stem pitting.

.7 Yoke bushing: Ni-Resist, minimum melting point above 954 degrees C.

.8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.

.9 Disc: ball type with 35 degrees taper seat.

.10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.

.11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.

.12 Operator: see elsewhere in this Section.

2.4 VALVE OPERATORS

.1 Handwheel: on all valves.

.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.5 CHECK VALVES

.1 65mm (2½") and over: Flanged ends, Class 150: swing check.

.1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.

.2 Cap studs: to ASTM A193/A193M Type B7.

.3 Cap nuts: to ASTM A194/A194M Type 2H.

.4 Body/cap joint: male-female face with corrugated metallic gasket.

.5 Disc: heat treated corrosion and heat resistant 13% chromium steel.

.6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.

.7 Hinge: ASTM A182/A182M.

2.6 SILENT CHECK VALVES

.1 Construction:

.1 Body: cast steel with integral seat.

.2 Pressure rating: Class 125.

.3 Connections: Flanged ends.

.4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.

.5 Stainless steel spring, heavy duty.

.6 Seat: regrindable.

Part 3 Execution

3.1 INSTALLATION

.1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.2 Align valves for easy access and identification when several service lines are installed together.

.3 Use line size throughout with the exception of control valve bypasses. Size control valve bypass valves equal to control valve.

.4 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.5 Locate valves on the main side of the unions or flanges of the equipment to allow servicing, maintenance, and equipment removal.

.6 Remove internal parts before soldering.

.7 Locate valves on the main side of the unions or flanges of the equipment.

.8 Provide drain valves at main shut-off valves, low points of piping, and equipment and terminal units.

3.2 VALVE SCHEDULE

.1 Provide valves as indicated on drawings and the following schedule:

.1 Check Valves – Silent:

.1 Discharge of the following system pumps:

.1 Chilled water pumps (if triple duty valves are not provided)

.2 Condensate pumps

.3 Feedwater pumps

.4 Heating water pumps (if triple duty valves are not provided)

.2 Check Valves – Swing:

.1 Backflow prevention

.3 Circuit Balancing Valves:

.1 Branch pipe take-offs from mains and sub-mains

.2 Heating/cooling coils

.3 Pump discharge (if triple duty valves are not provided)

.4 Gate Valves:

.1 Branch take-offs& vertical risers (where indicated on drawings)

.2 Isolating Service -Isolate equipment and vertical risers

.3 Shut-off

.5 Globe and Angle Globe Valves:

.1 Control device

.2 Meter bypass

.3 Throttling service

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by cast steel valve installation.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.

.1 Leave work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.3	Hydronic Systems: Copper	Section 23 21 13.01
.4	Hydronic Systems: Steel	Section 23 21 13.02
.5	Hydronic Piping Specialties	Section 23 21 16

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1	ANSI/ASME B1.20.2M-[2006]	Pipe Threads, 60 deg. General Purpose (Metric).
.2	ASME B16	Fittings and Valves Package.
.3	ANSI/ASME B16.1-[2010]	Grey Iron Pipe Flanges and Flanged Fittings. Classes 25, 125, and 250.
.4	ANSI/ASME B16.10-[2009]	Face-to-Face and End-to-End Dimensions Valves.
.5	ANSI/ASME B16.11-[2011]	Forged Fittings, Socket-Welding and Threaded.
.6	ANSI/ASME B16.25-[2007]	Buttwelding Ends.
.7	ANSI/ASME B16.34-[2009]	Valves Flanged, Threaded and Welding End. Includes Supplement (2010).

.2 ASTM International (ASTM)

.1	ASTM A126-[04 (2009)]	Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
.2	ASTM B62-[09]	Standard Specification for Composition Bronze or Ounce Metal Castings.
.3	ASTM B209-[10]	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 Canadian Registration Number (CRN)

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1	MSS SP-78-[2011]	Cast Iron Plug Valves, Flanged and Threaded Ends.

1.3 QUALITY ASSURANCE

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body"

- .1 Manufacturer's name or trademark
- .2 Products to have CRN registration numbers
- .3 Pressure rating
- .4 Flow direction

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

- .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

- .1 Submit detailed shop drawings clearly indicating, at a minimum, the following:
  - .1 Manufacturer and model
  - .2 Size and connection type
  - .3 Pressure rating
  - .4 Materials of construction
  - .5 Intended service

1.5 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

- .1 Furnish following spare parts:
  - .1 Valve seats: one for every 10 valves each size, minimum 1.
  - .2 Discs: one for every 10 valves, each size. Minimum 1.
  - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
  - .4 Valve handles: 2 of each size.
  - .5 Gaskets for flanges: one for every 10 flanged joints.

.6 Lockshield keys: Where lockshield valves are specified, provide 10 keys of each size – malleable iron cadmium plated.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PLUG VALVES

.1 Class 125, lubricated plug valve with cast iron body, plug and bonnet, standard port, flanged ends or threaded ends. Multiple packing ring, stem seal and resilient plug facing materials suitable for hot water/glycol service to 121°C (250°F).

.2 Valves shall be furnished with a lubricating/sealing system to provide a means for delivering lubricant/sealant to the body-plug interface.

.3 Lever operator with adjustable open position memory stop up to 100mm (4”) valves, heavy duty gear reducer handwheel operator with adjustable open position memory stop for valves 150mm (6”) and larger.

.4 Plug valves that are to be used for balancing are to have upstream and downstream flow taps. Fittings are to consist of two (2) 3mm (1/8”) air valves with sealing caps or two (2) 3mm (1/8”) petcocks with quick disconnect couplings.

.5 Valve to manufactured in accordance with MSS SP-78.

.6 Rating: Minimum 1206 kPa (175 psi) non-shock cold working pressure (CWP)

2.2 VALVE OPERATORS

.1 Provide one plug cock wrench for every ten plug cocks sized 50mm (2”) and smaller, minimum of one. Provide each plug cock sized 65mm (2½”) and larger with a wrench, with set screw.

.2 Provide valves larger than 100mm (4”) located more than 2.1m (7 ft) from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5m (5 ft) above floor and hook to clips to arrange to clear walking aisles.

Part 3 Execution

3.1 INSTALLATION

.1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.2 Align valves for easy access and identification when several service lines are installed together.

.3 Use line size valves throughout.

.4 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.5 Locate valves on the main side of the unions or flanges of the equipment to allow servicing, maintenance, and equipment removal.

.6 Locate valves on the main side of the unions or flanges of the equipment.

.7 A single plug valve may be substituted for a series arrangement of a balancing and gate valve on heating glycol, and chilled water service in mechanical rooms.

3.2 INSTALLATION OF LUBRICATED PLUG VALVES

.1 Install with line pressure acting to hold plug against body port[s].

  .1 Cut off from higher pressure.

.2 Determine type of sealing compound for particular application.

.3 Ensure even distribution of sealing compound and tight shut-off by opening and closing valve 3 times minimum.

.4 Ensure that plug is free to float when operating valve by easing valve off body.

.5 Determine frequency of re-lubrication during commissioning of remainder of system.

1.1 VALVE SCHEDULE

.1 Provide valves as indicated on drawings and the following schedule:

  .1 Plug Valves

    .1 Balancing service where shut-off or isolating valve is also provided

    .2 Water system for throttling service

3.3 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.3	Hydronic Systems: Copper	Section 23 21 13.01
.4	Hydronic Systems: Steel	Section 23 21 13.02
.5	Hydronic Piping Specialties	Section 23 21 16

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1	ASME B1.20.1-2013	Pipe Threads, General Purpose (Inch).
.2	ASME B16.1-2015	Grey Iron Pipe Flanges and Flanged Fittings: Classes 25,125 and 250.
.3	ANSI/ASME B16.5-2017	Pipe Flanges and Flanged Fittings: NPS ½ through 24.
.4	ANSI/ASME B16.11-2016	Forged Fittings, Socket-Welding and Threaded.
.5	ANSI/ASME B16.25-2017	Buttwelding Ends.
.6	ANSI/ASME B16.34-2017	Valves - Flanged, Threaded and Welding Ends.

.2 American Petroleum Institute (API)

.1	API Std. 609-16	Butterfly Valves: Double Flanged, Lug- and Wafer-Type.

.3 ASTM International (ASTM).

.1	ASTM A126-04 (2019)	Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
.2	ASTM A536-84 (2019)e1	Standard Specification for Ductile Iron Castings.
.3	ASTM B62-17	Standard Specification for Composition Bronze or Ounce Metal Castings.
.4	ASTM B209M-14	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].

.4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1	MSS SP-67-2017	Butterfly Valves.

1.3 QUALITY ASSURANCE

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body”

- .1 Manufacturer’s name or trademark
- .2 Products to have CRN registration numbers
- .3 Pressure rating
- .4 Flow direction

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

- .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

- .1 Submit detailed shop drawings clearly indicating, at a minimum, the following:
  - .1 Manufacturer and model
  - .2 Size and connection type
  - .3 Pressure rating
  - .4 Materials of construction
  - .5 Intended service

1.5 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

- .1 Furnish following spare parts:
  - .1 Valve seats: one for every 10 valves each size, minimum 1.
  - .2 Discs: one for every 10 valves, each size. Minimum 1.
  - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
  - .4 Valve handles: 2 of each size.
  - .5 Gaskets for flanges: one for every 10 flanged joints.

.6 Lockshield keys: Where lockshield valves are specified, provide 10 keys of each size – malleable iron cadmium plated.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 BUTTERFLY VALVES

.1 Lug Style – 65mm (2½”) and larger:

.1 Valve body to be cast iron, lug style, 50mm (2") extended neck for insulating, aluminum bronze alloy disc with EPDM rubber seat and seals. Stem shall be 416 stainless steel and shall not have exposed stem to disc fasteners.

.2 Sizes 65mm to 150mm (2½" to 6") shall be lever operated with 10-position throttling plate; sizes 200mm (8") and larger shall have gear operators.

.3 Valve shall be capable for use as isolation valves or dead-end service at full pressure without the need for downstream flanges.

.4 Valve to be manufactured in accordance with MSS SP-67.

.5 Rating: 1379 kPa (200 psi) non-shock cold working pressure (CWP)

.2 Grooved – 65mm (2½”) and larger:

.1 Valve body to be ductile iron encapsulated with polymer coating, grooved end, 50mm (2") extended neck for insulating, EPDM rubber encapsulated ductile iron disc. Stem shall be 416 stainless steel and shall not have exposed stem to disc fasteners.

.2 Sizes 65mm to 150mm (2½" to 6") shall be lever operated with 10-position throttling plate; sizes 200mm (8") and larger shall have gear operators.

.3 Valve shall be capable for use as isolation valves or dead-end service at full pressure without the need for downstream flanges.

.4 Valve to be manufactured in accordance with MSS SP-67.

.5 Rating: 2068 kPa (300 psi) non-shock cold working pressure (CWP)

.6 1379 kPa (200 psi) non-shock cold working pressure (CWP) – 300mm (12”) only

Part 3 Execution

3.1 PREPARATION

.1 Valve and mating flange preparation.

.1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.

.2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.

.3 Install butterfly valves with disc in almost closed position.

.4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

.1 Install in accordance with manufacturer's instructions.

.2 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.3 Align valves for easy access and identification when several service lines are installed together.

.4 Use line size valves throughout.

.5 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.6 Locate valves on the main side of the unions or flanges of the equipment to allow servicing, maintenance, and equipment removal.

.7 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.

.8 Verify suitability of valve for application by inspection of identification tag.

.9 Handle valve with care so as to prevent damage to disc and seat faces.

.10 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 VALVE SCHEDULE

.1 Provide valves as indicated on drawings and the following schedule:

.1 Butterfly Valves:

.1 Branch take-offs& vertical risers (where indicated on drawings)

.2 Isolating Service -Isolate equipment and vertical risers

.3 Shut-off

3.4 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Pipe hangers and supports.

.2 Duct hangers and supports.

.3 Flashing for mechanical equipment.

.4 Sleeving for mechanical equipment.

.5 Equipment bases and supports.

.6 Pipe anchors.

.7 Access Doors.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)

ANSI/ASME B31.1	Power Piping, (SI Edition).

.2 American Society for Testing and Materials (ASTM)

ASTM A125	Specification for Steel Springs, Helical, Heat-Treated.
ASTM A307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
ASTM A563	Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1	MSS SP58	Pipe Hangers and Supports - Materials, Design and Manufacture.
.2	MSS SP69	Pipe Hangers and Supports - Selection and Application.
.3	MSS SP89	Pipe Hangers and Supports - Fabrication and Installation Practices.

.5 National Fire Protection Association (NFPA)

.1	NFPA 13	Standard for the Installation of Sprinkler Systems

.6 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada 2015 (NPC).

.7 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible

.8 Underwriter's Laboratories of Canada (ULC)

1.3 QUALITY ASSURANCE

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.

.3 Ensure that hangers, supports, guides, anchors secure equipment and piping in place, prevent vibration, maintain grade and do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Submit shop drawings and product data for the following items:

.1 Access doors

.2 Bases, hangers and supports

.3 Connections to equipment and structure

.2 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

1.5 CLOSEOUT SUBMITTALS

.3 Provide maintenance and operation data in accordance with Section 01 78 00 – Closeout Submittals.

1.6 DELIVERY & STORAGE

.4 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 WASTE MANAGEMENT AND DISPOSAL

.5 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 INSERTS

.1 Provide inserts to cast in concrete of malleable cast iron or galvanized steel and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Furnish self-drilling expansion shell for poured-in-place concrete if the concrete is set. Under no circumstances will Ramset pins or other explosive type pins be allowed.

.3 Size inserts to suit threaded hanger rods.

2.2 PIPE HANGERS AND SUPPORTS

.1 Hangers for steel piping systems:

Service	Hanger Type	Material	Finish
1. Nominal pipe size 12mm to 50mm:			
All services	Adjustable ring	Carbon steel	Black, prime coated
2. Nominal pipe size 50mm to 100mm:			
All services	Adjustable clevis (heavy duty)	Carbon steel	Black, prime coated
3. Nominal pipe size 150mm and larger:			
Hot piping	Adjustable steel yoke pipe roll	Cast iron roll, carbon steel yoke, roll rod and hex nuts	Black, prime coated
4. Nominal pipe size 150mm and larger:			

Service	**Hanger Type**	**Material**	**Finish**
Cold piping	Adjustable clevis (heavy duty)	Carbon steel	Black, prime coated

.2 Hangers for copper and special material piping systems:

Service	**Hanger Type**	**Material**	**Finish**
5. Nominal pipe size 15mm to 50mm:			
All services	Adjustable ring	Carbon steel	Copper plated
6. Nominal pipe size 50mm to 100mm:			
All services	Adjustable ring	Carbon steel	Copper plated

.3 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.

.4 Use components for intended design purpose only. Do not use for rigging or erection purposes.

.5 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods. Cast iron roll and stand for hot pipe sizes 150mm (6”) and over. Cup washers for hot piping below 150mm (6”).

.6 Wall Support, Pipe Sizes to 75mm (3”): Cast iron hook.

.7 Wall Support, Pipe Sizes 100mm (4”) and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150mm (6”) and over.

.8 Vertical Support: Steel riser clamp.

.9 Floor Support, Pipe Sizes to 100mm (4”) and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier or steel support.

.10 Floor Support, Hot Pipe Sizes 125mm (5”) and Over: Adjustable cast iron roll and stand, steel screws and concrete pier to steel support.

.11 Design hangers so they cannot become disengaged by movements of supported pipe.

.12 Provide copper plated hangers and supports for copper piping.

.13 Provide galvanized hangers and supports for galvanized piping.

2.3 HANGER RODS

.1 Provide galvanized steel rods, threaded both ends, threaded one end, or continuous threaded.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, ULC listed and FM approved (where required).

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

  .1 64 kg/m3 density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:

  .1 Curved plate 300mm (12”) long, with edges turned up, welded-in centre plate for pipe sizes 15mm (½”) and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with ±5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report(CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel +20%. Difference between total travel and actual travel 25mm (1”) minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 15mm (½”) minimum, 50mm (2”) maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50mm (2”): use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger to be complete with factory calibrated travel stops.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with ±5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Division 05 – Metals. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

.1 Provide templates to ensure accurate location of anchor bolts.

2.10 HOUSEKEEPING PADS

.1 For base-mounted equipment: Reinforced concrete bases poured directly on structural floor slab. Housekeeping pads to be at least 100mm (4”) high and extend at least 100mm (4”) beyond the equipment base plates, and with chamfered edges.

2.11 DUCT HANGERS AND SUPPORTS

.1 Conform to SMACNA manuals.

2.12 FLASHING

.1 Steel Flashing: 0.5mm (26gauge) galvanized steel.

.2 Lead Flashing: 24.4kg/m² (5lb/ft) sheet lead for waterproofing, 4.88kg/m² (1 lb/ft²) sheet lead for soundproofing.

.3 Safes: 24.4kg/m² (5lb/ft²) sheet lead or 0.5mm (26gauge) neoprene.

.4 Caps: Steel, 0.8mm (22 gauge) minimum, 1.6mm (16 gauge) at fire resistance structures.

2.13 ACCESS DOORS

.1 Types:

.1 Flush Surface (Drywall, Plaster, Masonry, Tile) – Flanged Door: Steel universal flush access door with concealed bar hinge and rounded safety corners; stainless steel screwdriver operated cam latch.

.2 Drywall Surface – Hidden Flange: Steel access door with concealed bar hinge and rounded safety corners; flange of textured galvanized steel drywall taping bead with pre-punched holes; installed after drywall; screwdriver operated cam latch.

.3 Plaster Walls and Ceilings: Steel access door with expansion casing bead and 75mm (3”) wide galvanized lath surround recessed 19mm (¾”) to receive plaster; stainless steel screwdriver operated cam latch; white prime coat finish.

.4 Acoustic Plaster: 15mm (⅝") recessed steel access door with self-furring lath and 75mm (3") galvanized lath surround recessed 19mm (¾") to receive plaster; screwdriver operated cam latch; white prime coat finish.

.5 Acoustical Tile Ceilings: Steel access door recessed 25mm (1") to receive acoustic tile; concealed hinge; screwdriver operated cam latch; white powder coat finish.

.6 Fire Rated Walls: Self-closing, self-latching door; ULC – 2 hour "B" label; For use when temperature rise is not a factor; concealed hinge; universal self-latching bolt operated by either a knurled knob or flush key; white baked enamel finish.

.7 Fire Rated Walls & Ceilings: Self-closing, self-latching door with 50mm (2") fire rated insulation; ULC – 2 hour "B" label with a maximum temperature rise of 139°C (250°F) after 30 minutes; For use when temperature rise or heat transmission is a factor; concealed hinge; universal self-latching bolt operated by either a knurled knob or flush key; white baked enamel finish.

.8 Fire Rated Ceilings: Self-closing, self-latching, inward opening door with 50mm (2") fire rated insulation; ULC – 2 hour "B" label with a maximum temperature rise of 139°C (250°F) after 30 minutes; For use when temperature rise or heat transmission is a factor; concealed hinge; universal self-latching bolt operated by either a knurled knob or flush key; white baked enamel finish.

.2 Construction

.1 Non-Rated Doors: One piece outer flange welded to mounting frame; Continuous, concealed hinge; Doors 400mm x 400mm (16"x16") and smaller – 16 gauge door, 18 gauge mounting frame; Doors over 400mm x 400m (16"x16") – 14 gauge door, 16 gauge mounting frame.

.2 Rated Doors: 25mm (1") wide flange; Continuous, concealed hinge; 20 gauge door, 16 gauge mounting frame.

.3 Stainless steel screwdriver operate cam latch (non-rated doors); Universal self-latching bolt operated by a knurled knob or flush key (rated doors).

.4 Steel access doors: 5 stage iron phosphate preparation with prime coat of grey baked enamel.

.5 Stainless steel doors: #4 satin polish.

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 GENERAL REQUIREMENTS

.1 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.

.2 Select hangers and supports for the service and in accordance with manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.3 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.

.4 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.

.5 No percussion type fastening of any kind will be permitted without prior approval.

.6 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.

.7 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.

.8 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.

.9 Obtain approval prior to using percussion type fastenings.

.10 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

.11 Provide rigid anchors for ducts and pipes immediately after vibration isolation connections to equipment unless spring hangers are specified.

3.3 INSERTS

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100mm (4”).

.3 For poured-in-place concrete, place inserts in a manner such that they are not disturbed during construction or interfere to the detriment of the strength of the structure.

.4 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed 100mm (4”) minimum square steel plate and nut above slab.

.6 Supply all templates, special frame inserts, etc., required to accommodate equipment supplied under this section and turn over to the contractor for installation. It is the responsibility of this section to ensure the correct placement and mounting of these items.

.7 All cutting and patching required to accommodate the installation of inserts is the responsibility of this section, but the appropriate trades are to do the work in a manner satisfactory to the architect.

3.4 PIPE HANGERS AND SUPPORTS

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size mm (in)	Distance Between Supports mm (in)		Hanger Rod Diameter mm (in)
	Steel	Copper	
15 (½”) to 20 (¾”)	1800 (72”)	1500 (60”)	10 (3/8”)
25 (1”) to 40 (1½”)	2100 (84”)	1800 (72”)	10 (3/8”)
50 (2”) to 65 (2½”)	3000 (120”)	2400 (96”)	10 (3/8”)
75 (3”) to 100 (4”)	3600 (144”)	3000 (120”)	15 (½”)
150 (6”) to 300 (12”)	4200 (168”)	4000 (160”)	20 (¾”)
350 (14”) to 450 (18”)	6000 (240”)	6000 (240”)	25 (1”)

.2 Install hangars for domestic water, storm and sanitary piping as per the requirements of the National Plumbing Code of Canada 2015.

.3 Install hangers for natural gas piping as per the requirements of CSA B149.1-15 – Natural Gas and Propane Installation Code.

.4 Install hangers for fire protection piping as per the requirements NFPA 13-2013 – Standard for the Installation of Sprinkler System.

.5 Install hangers to provide minimum 15mm (½”) clear space between finished covering and adjacent work.

.6 Use oversize hangers to accommodate pipe insulation thickness. For pipes up to 50mm (2”) use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65mm (2½”) and over use insulation protection saddle.

.7 Place a hanger within 300mm (12”) of each horizontal elbow.

.8 Use hangers which are vertically adjustable 40mm (1½”) minimum after piping is erected.

.9 On insulated copper piping, affix lead or other approved backing to ensure no contact between copper and ferrous hanger or other work.

.10 Support vertical piping not subject to expansion or contraction with bolted steel riser clamps at each floor level or a maximum of 3000mm (10'-0"), whichever is shorter. Secure vertical cast iron soil pipe with drive hooks at 1500mm (60") intervals set below hubs, and by riser clamps at each floor level.

.11 Vertical piping subject to expansion or contraction where grooved joint couplers are used shall be supported with riser clamps at each floor level. Ensure at least one grooved joint occurs between each floor.

.12 Vertical piping subject to expansion or contraction where welded or threaded shall be supported and anchored at maximum 20mm intervals with expansion joints. Provide guides at each floor.

.13 Place piping hung or supported by rising or clevis hangers directly onto the hanger and insulation carried over the hanger, finish insulation neatly where the hanger protrudes over the insulation. Provide piping 50mm and over with pipe covering protection saddles and insulation butted against the saddle, also provide insulation between the pipe and saddle.

.14 Where piping is supported from floor, use cast iron adjustable pipe saddle supports with locknut nipple, floor flange and concrete pier or steel support. Where provision for expansion or contraction is required, use adjustable pipe roll stands with vertical adjustment and concrete pier or steel support.

.15 Support cast iron horizontal drainage pipe near each hub and on each side of gasket and clamp joints, with 1500mm (60") maximum spacing between hangers.

.16 For all horizontal drainage pipe (sanitary and storm) below structural slabs, provide clevis ring hangers supported from the structural slab.

.17 Provide insulation saddles for insulated pipe.

.18 For steel cold water insulated pipe, use prefabricated insulated shields with high density insulation and vapor barrier. Shield length to be four times insulation outside diameter.

.19 For all insulated copper piping, use shields of 1.2mm galvanized sheet metal, length two times insulation outside diameter and ½ the insulation circumference.

.20 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.21 Where practical, support riser piping independently of connected horizontal piping.

3.5 DUCT HANGERS AND SUPPORTS

.1 Duct hangers and supports in accordance with SMACNA standards.

3.6 HANGAR FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

.1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

3.7 FLASHING

.1 Flash and counter-flash where mechanical equipment passes through weather or waterproofed walls, floors and roofs.

.2 Provide curbs for mechanical roof installations 300mm (12”) minimum high. Flash and counter-flash with galvanized steel, soldered and make waterproof. Coordinate with roofing contractor.

.3 Provide lead acoustic flashing around duct and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

.4 Flash vent and soil pipes projecting 75mm (3”) minimum above finished roof surface with lead worked 25mm (1”) minimum into hub, 200mm (8”) minimum clear on sides with minimum 600mm x 600mm (24”x24”) sheet size. For pipes through outside walls, turn flange back into wall and caulk.

3.8 ACCESS DOORS

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves

.2 Volume and splitter dampers

.3 Fire Dampers

.4 Coils and terminal units

.5 Expansion joints

.6 Control components

.7 Cleanouts and traps

.2 Where access is required through removable acoustic tile ceilings, identify with coloured round stickers (6mm diameter) on all tees adjacent the tiles to be used for access.

.3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.

.4 Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms.

.5 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface and pattern if this is available at the time the units are ordered.

.6 Provide ULC listed fire rated access doors when installed in fire rated walls and ceilings.

.7 300mm x 300mm (12”x12”) minimum, for inspection and hand access.

.8 450mm x 450mm (18”x18”) minimum, larger if indicated on drawings, where entry is required and access is difficult.

.9 Size access door to suit masonry modules when located in a masonry wall.

.10 Refer to architectural reflected ceiling plan for size and location of additional access doors.

.11 Ensure the number of access doors required is maintained at a minimum by locating mechanical components requiring access in accessible locations such as removable tile ceilings, etc.

.12 Provide a schedule of access doors showing location, type and size, together with samples, to the consultant for approval before installation. Avoid locating access doors in feature walls or ceilings without prior approval of the consultant.

.13 Access doors will be provided under Section 23 05 29, but installed by the trade governing the surface in which they are to be installed.

3.9 LIFTING EYES AND HOISTS

.1 Ensure that all motors, pumps and components that weigh over 68 kg (150 lb) are equipped with a lifting eye.

.2 Above all banks of pumps, provide two eye hooks to accept a chain hoist to be used for pump maintenance and removal.

3.10 METAL SUPPORTS

.1 Except where detailed on structural drawings, design, construct and install metal supports, stands, platforms and other metal structures including maintenance platforms required for and associated with the mechanical equipment. Ensure that structures are designed so that loads and impact loads are properly distributed into building structure.

.2 Where equipment is indicated or specified to be floor mounted on stands or legs, fabricate these from structural steel section and/or steel pipe with adequate bracing and steel plate flanges for bolting to the concrete base or floor.

.3 Where ceiling or wall mounting is indicated or specified, use a suspended platform, bracket or shelf, whichever is most suitable for the equipment and its location. Fabricate from standard structural steel sections and plate and/or steel pipe. Ensure that these structures are adequately fastened to the building structure.

.4 Supports must be large enough to support the equipment along the entire length and width. Adequate provision must be made to install isolators if necessary either below the support or between support and the equipment.

.5 If necessary to provide continuous and rigid support for equipment components, mount all components on channel or "I" beams before mounting on isolators.

.6 Vertical tanks are to be supported by adjustable jack legs and horizontal tanks by saddles with correct curvature for tank shell.

3.11 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

 .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Vibration isolation for piping, ductwork and equipment

.2 Equipment isolation bases

.3 Flexible piping connections

.4 Resilient pipe anchors and guides

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Hangers and Supports for HVAC Piping and Equipment	Section 23 05 29

1.3 REFERENCE STANDARDS

.1 National Fire Protection Association (NFPA)

.1 NFPA 13-2013 Standard for the Installation of Sprinkler Systems

.2 National Research Council of Canada

.1 National Building Code of Canada – Alberta Edition 2019 (NBC(AE))

1.4 QUALITY ASSURANCE

.1 Supply all labor, materials, and equipment required and necessary to isolate and restrain the equipment as indicated on the drawings and specified herein and guarantee the function of the materials and equipment supplied.

.2 Provide and install appropriate vibration isolation materials/products on mechanical equipment so that Average Noise Criteria curves, as outlined in ASHRAE Guide, are not exceeded.

.3 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible supplier's technical representative.

.4 Provide attachment to both the equipment and the structure meeting the specified forces involved.

.5 All elastomeric components in type 1, type 2 isolation mounts shall be bridge bearing neoprene, meeting CSA Standard CAN3-S6 Section 11.10.

.6 All vibration isolators and bases shall be supplied by an approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.7 The work shall be carried out in accordance with the specification and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.8 Equipment supplier to ensure equipment is sufficiently rigid for isolator point loading. Project Mechanical Consultant must be advised of any equipment which requires an additional support base, at least 7 working days prior to tender closing.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 – Submittal Procedures.

  .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.

.2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.3 Shop drawings shall include, as a minimum, the following:

  .1 Descriptive Data:

    .1 Schedule of flexibly mounted equipment, referencing drawings by number.

    .2 Catalog cut or data sheets on vibration isolators.

  .2 Drawings:

    .1 Submit details of equipment bases including dimensions, structural member sizes and support point locations.

    .2 Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.

    .3 Submit details of mountings for floor supported equipment, piping and ductwork.

    .4 All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.

    .5 Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.

    .6 Complete flexible connecter details.

  .3 Provide an equipment isolation schedule that provides design data for each isolator including: spring O.D., free operating and solid heights, minimum static deflection, and ratio of horizontal to vertical stiffness.

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.6 CLOSEOUT SUBMITTALS

.1 Provide maintenance and operation data in accordance with Section 01 78 00 – Closeout Submittals.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 **Products**

2.1 DESCRIPTION

.1 Provide vibration isolation on all motor driven equipment with motors of 0.37 kW (0.5 HP) and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 0.37 kW (0.5 HP), provide neoprene grommets at the support points.

.2 Electrical cable connected to isolated equipment shall allow for a minimum ±25mm (±1”) of equipment movement in any direction.

.3 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness in selection of elastomers and do not exceed 60 durometer.

.4 Provide spring thrust restraints on all fans (except vertical discharge) in excess of 1 kPa (0.15 psi) static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

.5 Isolators and restraining devices which are factory supplied with equipment shall meet the requirements of this section.

.6 Provide concrete inertia bases where specified or required by equipment manufacturer located between all vibrating equipment and the vibration isolation elements. Provide inertia bases on base mounted pumps over 7.5 kW (10 HP), except slab on grade installations. Refer to structural specifications for concrete work. Concrete work by General Contractor.

2.2 ISOLATORS

.1 All isolators shall be of the following types, supplied by approved manufacturers.

.2 Vibration isolators shall have minimum operating static deflections as indicated in the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capacities.

.3 Isolation hangers shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.

.4 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as otherwise indicated on the project documents. Springs shall be color coded or otherwise identified to indicate load capacity.

.5 Isolator types shall be as follows:

.3 Type 1 – Fiberglass Pad Isolator (Floor Mounted Equipment)

.1 Isolator pads shall be pre-compressed molded fiberglass pads individually coated with a flexible, moisture impervious elastomeric membrane.

.2 Pads shall be molded from fine (6.9 microns) bonded annealed glass fibers which have been stabilized during manufacture by compressing the material ten (10) times.

.3 Pads shall have a constant natural frequency over the operating load range, and the stiffness shall increase proportionately with load applied.

.4 Pads shall be no taller than the shortest horizontal dimension. Where the equipment base does not provide a uniform load surface, steel plates shall be bonded to the top of the pads.

.4 Type 1 – Rubber Pad Isolators

.1 Isolation pads shall be neoprene elastomer in-shear pads, used in conjunction with steel shims where required, having static deflections as tabulated.

.2 Isolation pads shall be elastomer in-shear and shall be molded using 17,237 kPa (2500 psi) minimum tensile strength, oil resistant neoprene compounds with no color additives. Pads to be used in conjunction with steel shims where required, and will have static deflections as tabulated.

.3 Pads shall be 50 durometer and designed to permit 413.7 kPa (60 psi) loading at a maximum rated deflection of 4mm (0.15").

.4 When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate.

.5 Type 2 – Rubber Mounts (Floor Mounted Equipment)

.1 Neoprene mountings shall be molded from oil-resistant compounds and have a minimum static deflection of 9mm (0.35”).

.2 All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and screw on top.

.6 Type 2 – Rubber Hanger (Suspended Equipment)

.1 Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding 15mm (0.57”) shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap.

.2 The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.

.3 The hanger shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or short circuit.

.7 Type 3- Spring Isolators (Floor Mounted Equipment)

.1 Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 6mm (¼) neoprene acoustical friction pad between the baseplate and the support.

.2 All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal.

.3 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

.8 Type 3 – Spring Isolators (Suspended Equipment, Piping & Ductwork)

.1 Hangers shall consist of rigid steel frame containing a minimum 32mm (1-¼”) thick natural rubber, or neoprene, rubber element at the top and a steel spring seated in a steel washer reinforced with a natural rubber, or neoprene, cup on the bottom.

.2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

.3 The natural rubber, or neoprene, element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the natural rubber, or neoprene, element stacked on top of the spring.

.4 Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

.9 Type 3 – Pre-compressed Spring Isolators (Suspended Equipment, Piping & Ductwork)

.1 Hangers shall consist of rigid steel frame containing a minimum 32mm (1-¼”) thick natural rubber, or neoprene, rubber element at the top and a steel spring seated in a steel washer reinforced with a natural rubber, or neoprene, cup on the bottom.

.2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

.3 The natural rubber, or neoprene, element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the natural rubber, or neoprene, element stacked on top of the spring.

.4 Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

.5 Hangers shall be pre-compressed and locked at the rated deflection by means of a steel pre-compression washer to keep the piping, or equipment, at a fixed elevation during installation.

.6 The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale.

.10 Type 3 – Spring Isolators (Suspended Ductwork)

.1 Hangers shall consist of rigid steel frame containing a steel spring seated in a steel washer reinforced with a natural rubber, or neoprene, cup on the bottom.

.2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

.3 The natural rubber, or neoprene, element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the natural rubber, or neoprene, element stacked on top of the spring.

.4 Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

.11 Type 4 – Restrained Spring Isolators (Floor Mounted Variable Weight Equipment)

.1 Laterally stable, vertically restrained spring isolators with welded steel housings and heavy top plates for supporting equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 1/4" (6 mm) thick, bonded to the base plate. Housings shall include vertically restraining limit stops.

.2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

.3 Minimum clearance around the restraining bolts and between the housing and the spring shall be 13mm (½"). Top plate and restraining bolts shall be out of contact with the housing during normal operation and neoprene grommets shall be incorporated to minimize short-circuiting of restraining bolts.

.4 For outdoor applications, housing must be hot-dip galvanized. For indoor applications, powder-coated finish for the housing is acceptable.

.12 Type 4 – Closed Spring Isolators (Floor Mounted Variable Weight Equipment)

.1 Floor mounted spring isolators with telescoping housings and bolts for leveling and securing equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 6mm (¼") thick, bonded to the base plate.

.2 Housings shall be fabricated or welded steel telescoping housings that incorporate neoprene stabilizers to minimize short circuiting and provide vertical damping.

2.3 BASES

.1 All bases shall be of the following types, supplied by approved manufacturers.

.13 Type A – Direct Isolation

.1 No base required. Isolators may be attached directly to the supported equipment.

.14 Type B – Structural Bases

.1 Bases shall be fabricated from structural beam sections with welded isolator brackets and pre-located anchor bolt holes, and shall be designed and supplied by the isolation materials manufacturer.

.2 Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows.

.3 Section depth of each member shall be greater than 10% of the longest span between supporting isolators, or as shown on the drawings or indicated in the project documents. Lateral cross members shall be added, as necessary, to form a structurally integral, welded frame to provide a rigid, distortion-free frame to support and anchor separate equipment components or driving and driven members.

.4 Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment and provide a base clearance of 25mm (1”).

.15 Type B – Structural Rails

.1 Bases shall be structural beam sections, with welded on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer.

.2 Beam sections shall not be structurally connected to each other. Structural members shall have sufficient rigidity to prevent distortion of the equipment, as determined by the vibration isolation manufacturer.

.3 Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment and provide a base clearance of 25mm (1”).

.16 Type C – Concrete Bases

.1 Bases shall be constructed of concrete cast into a prefabricated inertia base frame assembly designed and supplied by the vibration isolation manufacturer. Bases for split case pumps shall be large enough to provide support for suction and discharge elbows.

.2 Frame members shall be welded to form a structurally integral assembly, complete with primer-painted steel perimeter members, welded and tied reinforcing rods, recessed isolator brackets and equipment anchoring bolts.

.3 Bases shall be shipped ready for pouring of concrete fill in the field. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6"(150mm). The base depth need not exceed 12"(300mm) unless specifically recommended by the base manufacturer for mass or rigidity.

.4 Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Recessed isolator brackets shall be employed in all mounting locations to maintain a 25mm (1”) clearance below the base.

.17 Type D – Curb Isolation

.1 Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal.

.2 Aluminum members shall house electro-galvanized or powder coated springs selected for 20mm (¾”) minimum deflection. Travel to solid shall be 40mm (1½”) minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 6mm (¼”) so as not to interfere with the spring action except in high winds.

.3 Manufacturer's self-adhering closed cell sponge gasketing must be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM duct-like closure.

.4 Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details

.18 Type D – Curb Isolation

.1 Rails to support rooftop equipment shall be designed to provide isolation against the transmission of vibrations to the building structure.

.2 Rail assembly shall consist of extruded or roll-formed top and bottom members with spring isolators incorporated and with a continuous air and water seal provided for the entire rail perimeter.

.3 Spring isolators shall be selected and spaced according to weight distribution. Spring components shall meet all the specified characteristics as described in Type 3 – Spring Isolators (Floor Mounted Equipment).

2.4 HORIZONTAL THRUST RESTRAINTS

.1 Spring isolated air handling equipment shall be fitted with horizontal thrust restraints design to keep movement due to thrust to ±6mm (±0.25”) at equipment start and stop. The restraints shall be attached at the centerline of the thrust and symmetrical on each side of the unit.

.2 Thrust Restraints shall consist of high deflection, large diameter, laterally stable steel coil springs assembled into a threaded rod and angle bracket assembly. Coil springs shall have a lateral spring stiffness greater than 1.0 times the rated vertical stiffness to assure coil stability.

.3 Coil springs shall provide a minimum of 50% overload deflection capability to solid and shall be safe when temporarily loaded to solid capacity. Coil springs shall be polyester powder coated for corrosion protection and shall demonstrate successful completion of a 1000 hour salt spray test per ASTM Standard B-117.

.4 Thrust Restraints shall feature molded neoprene end load plate assemblies for light capacities or stamped steel end cups for heavier capacities. Thrust Restraints shall include threaded adjustment rod with zinc-plated hardware, and shall include primer painted fan and ductwork mounting bracket angles, bracket back-up plates, and complete fan / ductwork attachment hardware.

2.5 ACOUSTICAL SEALS

.1 Acoustical seals shall be used where indicated on drawings.

.2 Split seals shall consist of pipe halves with minimum 20mm (3/4") thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping.

.3 Seals shall project a minimum of 25mm (1") past either face of the wall. Where temperatures exceed 107°C (225°F), 10 lb. density fiberglass, with caulked ends, will be used in lieu of the sponge.

.4 Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member.

2.6 PIPE RISER ANCHORS

.1 Risers shall be restrained against excessive movement during service by the all directional acoustical pipe anchors designed to withstand the required installation and operating forces.

.2 Anchors are intended to be used in sets of two (2), and be oriented to effectively restrain the riser in all three directions, with particular emphasis on large and variable vertical loads that would be imparted by changes in the riser weight.

.3 Pipe anchors shall consist of two sizes of steel tubing separated by a minimum of 13mm (½“) thickness of 60 duro, or softer, neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Anchors shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design loads.

.4 Allowable loads on the isolation material shall not exceed 3.45 N/mm² (500 psi) and the design shall be balanced for equal resistance in any direction.

2.7 PIPE RISER GUIDES

.1 Risers shall be restrained against excessive lateral movement during service by the use of 2-axis resilient guides designed to withstand the required installation and operating forces. Guides are intended to be used in sets of two (2), and be oriented to effectively restrain the riser in all horizontal directions, but to allow free motion within their operating range in the vertical axis.

.2 Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 13mm (½") thickness of 60 durometer, or softer, neoprene. The height of the guides shall be preset with a set screw to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ±40mm (±1⅝") motion, or to meet location requirements.

2.8 FLEXIBLE PIPE CONNECTORS

.1 Braided spools for steel piping up to 50mm (2" diameter): Stainless steel inner core and braid welded; schedule 40 carbon steel NPT nipples; suitable for service at 1724 kPa (250 psi) at 120°C (250°F).

.2 Braided spools for copper piping: Bronze hose and braid; copper female sweat ends; suitable for 1035 kPa (150 psi) at 21°C (70°F).

Male Nipples
(Min. Lengths)

15x300mm (½"x12")	30x300mm (1¼"x12")	50x300mm (2"x12")
20x300mm (¾"x12")	40x300mm (1½"x12")	65x450mm (2½"x18")
25x300mm (1"x12")		

.3 Braided spools for steel piping 65mm (2½") and over: Stainless steel inner core and braid; 150lb raised face forged steel slip on flanges; suitable for service at 951 kPa (138 psi) at 120°C (250°F).

Flanged
(Min. Lengths)

75x300mm (3"x12")	150x450mm (6"x18")	300x600mm (12"x24")
100X300mm (4"x12")	200x450mm (8"x18")	350x750mm (14"x30")
125x450mm (5"x18")	250x450mm (10"x18")	400x800mm (16"x32")

2.9 FLEXIBLE RUBBER CONNECTORS

.1 Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 40mm to 600mm (1½" to 24") shall have a ductile iron external ring between the two spheres. Sizes 400mm to 600mm (16" to 24") may be single sphere. Sizes 20mm to 50mm (¾" to 2") may have one sphere, bolted threaded flange assemblies and cable retention.

.2 Minimum ratings:

.1 Through 400mm (16"): 1724 kPa at 77°C (250 psi at 170°F) and 1482 kPa at 121°C (215psi at 250°F)

.2 450mm to 600mm (18"to 24"): 1241 kPa at 77°C (180psi at 170°F) and 1034 kPa at 121°C (and 150psi at 250°F)

.3 Higher published rated connectors may be used where required.

.3 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 4 minutes before shipment.

.4 The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 13mm (½”) thick neoprene washer bushings large enough to take the thrust at 0.7 kg/mm2 (1000psi) of surface area may be used on unanchored piping as a noise break only.

.5 All expansion joints shall be installed on the equipment side of the shut off valves.

2.10 FLEXIBLE PUMP CONNECTIONS

.1 Install flexible connections for all centrifugal floor mounted pumps and in line pumps in such a manner that vibrations and transmission thereof are eliminated. Flexible connectors shall be twin sphere, peroxide cured EPDM, Kevlar reinforced, solid steel rings with raised face rubber flanged ends, ductile iron external ring between spheres.

Part 3 **Execution**

3.1 APPLICATION

.1 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.2 Coordinate work with other trades to avoid rigid contact with the building.

.3 Any contacts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the engineer’s attention prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

.4 The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls. Any rigid connections between equipment and the building shall not degrade the noise and vibration control system herein specified.

.5 Where piping connected to noise generating equipment is routed from the mechanical room through plumbing chases, position piping to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Provide an acoustical barrier such as fibrous material and resilient acoustical caulking or acoustical split wall seals. Refer to drawings for acoustic barrier locations and requirements. Submit proposed details to meet this requirement.

.6 Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

.7 Isolator hangers shall be installed with the housing a minimum of 6mm (¼”) below but as close to the structure as possible. Where isolator hangers would be concealed by non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.

.8 For all equipment mounted on vibration isolators, provide a minimum clearance of 50mm (2”) to other structures, piping, equipment, etc. All isolators shall be adjusted to make equipment level.

.9 Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.

.10 Provide spring thrust restraints on all fans (except vertical discharge) in excess of 1 kPa (0.15 psi) static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

.11 Horizontal limit springs shall be provided on fans operating in excess of 1.5 kPa (6” WG) static pressure, except vertical discharge fans, and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N.

.12 Provide spring-loaded thrust restraints for fans and air handling units where movement under any operating condition will exceed 10mm (0.375”).

.13 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing anchors.

.14 When recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.

.15 Where hold down bolts for isolators penetrate roofing membranes, provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene.

.16 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal.

.17 Provide vibration isolation for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.18 Set steel bases for 25mm (1”) clearance between housekeeping pad and base. Set concrete inertia bases for 50mm (2”) clearance. Adjust equipment level.

.19 Deflections 12mm (½”) and over shall use steel spring isolators.

.20 Deflections 5mm (¼”) and under shall use neoprene isolators.

.21 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.22 Adjustable, horizontal stabilizers on close spring isolators shall be adjusted so that the side stabilizers are clear under normal operating conditions.

.23 Co-ordinate with Division 3 for the provision of housekeeping pads at least 100mm (4”) high under all isolated equipment and where indicated on drawings. Provide at least 175mm (7”) clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.

.24 Bolt all equipment to the structure. Do not bridge isolation elements.

.25 Piping Isolation

.19 Isolate piping, either suspended or floor mounted, connected to vibration isolated equipment. At a minimum, the first three (3) hangers shall provide the same deflection as the equipment isolators to a maximum deflection of 50mm (2”). The remaining isolators shall have a minimum 25mm (1”) static deflection.

.20 Pipe vibration isolation is to be provided on the pipe for the distance noted in the table below. At a minimum, the first three (3) pipe hangers before and after vibration isolated equipment will have vibration isolation. Pipe hanger spacing is to be as noted in Section 23 05 29 – Hangers and Supports for HVAC Equipment and Piping.

Pipe Size	Distance from Vibrating Equipment
20mm (¼”)	4.5m (15’-0”)
25 to 100mm (1 - 4”)	15.0m (50’-0”)
150 to 200mm (6” - 8”)	18.0m (60’-0”)
250mm & Larger (10” & Larger)	21.0m (70’-0”)

.21 Type 2 or Type 3 isolators shall be used for pipe hanger vibration isolation. In noise-sensitive areas only Type 3 hangers are to be used.

.22 Spring hanger isolators shall be cut in to the hanger rods and installed after the system is filled. Alternatively, provisions must be made to ensure piping does not change height during installation and start-up.

.23 Floor supports for piping connected to vibration isolated equipment shall use Type 3 and Type 4 isolators. The first two (2) supports shall be a restrained spring type with a blocking feature. Where pipe stands are used to support elbows, a Type 1 isolator shall be used under the base of the pipe support.

.24 Piping attached to isolated equipment with flexible connections or to air handling units with internal vibration isolators meeting the requirements of these specifications is exempt from these requirements.

.26 Ductwork Isolation:

.25 Isolate all ductwork that is rigidly connected to isolated equipment for a minimum distance of 15m (50 ft) from the equipment. Ductwork attached to isolated equipment with flexible connections or to air handling units with internal vibration isolators is exempt from these requirements, unless noted otherwise on the drawings.

.1 Suspended ductwork shall be supported by Type 3 isolators with a minimum 25mm (1”) static deflection.

.2 Floor supported ductwork shall be isolated from the structure with Type 3 (Floor mounted equipment)

.27 Specified supplemental equipment base types can be deleted for unitary packaged air handling equipment having a rigid frame and casing providing a distortion free platform for attachment of vibration isolators.

.28 Noise and vibration isolator types and minimum operating static deflections for suspended, or floor mounted, sheet metal ductwork air plenums, pressure reducing valves, sound traps and similar air distribution elements shall be as follows:

.26 Type 3 hangers, or Type 3 floor mounts, with minimum operating static deflections equal to 50% of connected equipment isolator deflection, or 25mm (1”), whichever is greater, shall be used to support all sheet metal air distribution elements located within mechanical equipment rooms, traveling between equipment rooms, and for a minimum of 15m (50’) from connections to vibration isolation mechanical equipment.

.27 Type 3 hangers, or floor mounts, with minimum operating static deflection of 25mm (1”), shall be used to support all sheet metal ductwork having air velocities of 5.08 m/s (1000 fpm) and higher, which is supported by structures above or below spaces having noise criteria levels of NC 35 or lower.

.29 On completion of installation of all insolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment leaving equipment free to move on the isolation supports.

.30 Spring hangers shall be installed without binding.

.31 Adjust isolators as required and ensure springs are not compressed.

.32 Provide neoprene side snubbers or retaining springs where side torque or thrust may develop.

.33 Where movement limiting restraints are provided, they shall be set in a position with minimum 6mm (¼”) air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3g (0.006615 lb) without permanent distortion or damage.

.34 Wiring connections to isolated equipment shall be flexible.

.35 Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

3.2 INSPECTION

.1 The contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The contractor shall seek the representative's guidance in any installation procedures with which he is unfamiliar.

.2 A qualified representative of the isolator manufacturer shall inspect the isolated equipment after installation and submit a concise report stating any deficiencies in the installation.

.3 On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system.

.4 The installing contractor shall submit a report to the Engineer, including the manufacturer representatives' final report, indicating all isolation material is properly installed or steps to be taken by the contractor to properly complete the isolation work as per specification.

3.3 PERFORMANCE

.1 Install isolators of type and deflection as indicated on the Isolation Schedule or according to the following table, whichever provides the greater deflection.

Vibration Isolation Schedule (from 2007 ASHRAE Handbook)														
			Equipment Location											
						Floor Span								
			Slab on Grade			Up to 6.1m (20 ft)			6.1 to 9.1m (20 to 30 ft)			9.1 to 12.2m (30 to 40ft)		
Equipment Type	kW (HP) & Others	RPM	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)
Pumps														
Close-Coupled	≤5.59 (≤7.5)	All	B	2	6 (0.25)	C	3	19 (0.75)	C	3	19 (0.75)	C	3	19 (0.75)
	≥7.46 (≥10)	All	C	3	19 (0.75)	C	3	19 (0.75)	C	3	38 (1.50)	C	3	38 (1.50)
Large Inline	3.73 to 18.6 (5 to 25)	All	A	3	19 (0.75)	A	3	38 (1.50)	A	3	38 (1.50)	A	3	38 (1.50)
	≥22.4 (≥30)	All	A	3	38 (1.50)	A	3	38 (1.50)	A	3	38 (1.50)	A	3	64 (2.50)
Boilers (Fire-Tube)	All	All	A	1	6 (0.25)	B	4	19 (0.75)	B	4	38 (1.50)	B	4	64 (2.50)
Centrifugal Fans														
≤ 550Ø (≤ 22”Ø)	All	All	B	2	6 (0.25)	B	3	19 (0.75)	B	3	19 (0.75)	C	3	38 (1.50)
≥ 600Ø (≥ 24”Ø)	≤29.8 (≤40)	Up to 300	B	3	64 (2.50)	B	3	89 (3.50)	B	3	89 (3.50)	B	3	89 (3.50)
		300 to 500	B	3	38 (1.50)	B	3	38 (1.50)	B	3	64 (2.50)	B	3	64 (2.50)
		501 & Up	B	3	19 (0.75)	B	3	19 (0.75)	B	3	19 (0.75)	B	3	38 (1.50)
	≥37.3 (≥50)	Up to 300	C	3	64 (2.50)	C	3	89 (3.50)	C	3	89 (3.50)	C	3	89 (3.50)
		300 to 500	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)	C	3	64 (2.50)
		501 & Up	C	3	25 (1.00)	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems. Systems to be identified include the following:

- .1 Heating and Cooling Systems
- .2 Ventilation Systems

1.2 RELATED REQUIREMENTS

.1 Common Work Results for HVAC — Section 23 05 00

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

ASME A13.1-2007	Scheme for the Identification of Piping Systems

.2 Canadian Gas Association (CGA)

.1	CAN/CGA B149.1	Natural Gas and Propane Installation Code

.3 Canadian General Standards Board (CGSB)

.1	CGSB-1-GP-12c	Color Identification and Selection
.2	CAN/CGSB-1.60	Interior Alkyd Gloss Enamel.
.3	CAN/CGSB-24.3	Identification of Piping Systems

.4 Federal Standard 595C – Colors

.5 National Fire Protection Association (NFPA)

.1	NFPA 13	Standard for the Installation of Sprinkler Systems

.6 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms

1.4 QUALITY ASSURANCE

.1 Coordinate color coding of piping and equipment with work of Section 09 91 23 – Interior Painting.

.2 All painting identified in this section is to be performed by Section 09 91 23 – Interior Painting Contractor, under the direction of the Division 23 contractor.

.3 Color code mechanical equipment, piping and ductwork. Refer to Part 3 of this section.

1.5 DEFINITIONS

.1 For the purposes of this Section, the following definitions apply:

.2 Concealed: Piping, ductwork and equipment in trenches, shafts, furrings and suspended ceilings.

.3 Exposed: Piping, ductwork and equipment in mechanical rooms or otherwise not “concealed”.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

.2 Product Data:

.1 Submittals: in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product data to include paint color chips, other products specified in this section.

1.7 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.8 DELIVERY & STORAGE

.2 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 WASTE MANAGEMENT AND DISPOSAL

.3 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

Not Applicable

Part 3 Execution

3.1 GENERAL

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.2 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

3.3 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification of the following systems shall be as required by the codes noted.

.1 Natural gas as per CSA/CGA B149.1-15 – Natural Gas and Propane Installation Code.

.2 Sprinkler piping and systems as per NFPA 13-2013 – Standard for the Installation of Sprinkler Systems.

3.4 IDENTIFICATION LABELS

.1 Identification Labels for all mechanical piping and ductwork systems, to include:

.1 WHMIS Pictogram (as applicable), same color as legend letters.

.2 A lettered legend on a coloured background, defining the contents in the pipe, its pressure and temperature and the information necessary to define the hazard.

.3 Arrows to define the direction of flow, same colour as legend letters.

.4 50mm (2”) wide black tape at each end of the label, wrapped around the entire circumference of pipe/insulation to secure the Identification Labels.

.2 Identification Labels may be accomplished by paint, stenciling and/or factory fabricated labels. Labels shall cover full circumference of pipe or insulation.

3.5 LOCATION OF LABELS

.1 Orient labels on piping systems in visual sight lines while standing at floor levels.

.2 Locate labels as follows:

.1 Upstream of valves.

.2 Adjacent to changes in direction.

.3 Branches.

.4 Where pipes pass through walls or floors.

.5 On straight pipe runs at 6 m intervals.

.6 Where system is installed in pipe chases, ceiling spaces, shafts, or similar confined spaces, at entry and exit points and at access openings.

.7 At beginning and end points of each run and at each piece of equipment.

.3 Adhere labels to piping/insulation. Labels to cover entire pipe circumference. Secure both ends of labels with 50mm (2”) wide black tape around the entire pipe circumference.

3.6 DUCTWORK IDENTIFICATION

.1 Use 65mm high black stenciled letters with arrows indicating flow. Identify both systems number and type of air where possible.

.1 Duct identification to be:

Duct Service	Legend
Supply Air, Air Handling Unit # [ ]	S/A – AH-[ ]
Return Air, Air Handling Unit # [ ]	R/A – AH-[ ]
Outside Air Intake, Air Handling Unit # [ ]	O/A – AH-[ ]
Exhaust or Relief Air, Air Handling Unit # [ ]	E/A – AH-[ ]
Exhaust Air, Exhaust Fan # [ ]	E/A – EF-[ ]

.2 Maximum distance between markings to be no more than 15 meters maximum. Identify duct on each side of dividing walls or partitions and behind each access door.

.3 Division 23 contractor to apply stencil lettering only after the final finish has been applied.

3.7 PIPING IDENTIFICATION

.1 Identification Methods

.1 Piping identification system entails primary color, or pipe marker, secondary color strip, pipe service legend and direction of flow arrow

.2 Primary color, where required, shall be applied to pipe in its entirety.

.3 Secondary color strips minimum of 600mm (24”) long shall be applied at 6 meter (20 ft) intervals, at change of direction, at both sides of walls and floors where penetrated, at each piping rise or drop, at major branch connections and major valves, at service connections to equipment, and at least ones in each room through which piping passes.

.4 Legend shall be stenciled, capital block lettering, color as noted in Color Schedule. The size of lettering shall be as follows:

Outside Pipe Diameter (including covering) mm (in)	Minimum Height of Letters mm (in)
≤ 50 (≤ 2”)	25 (1”)
65 to 150 (2½” to 6”)	30 (1¼”)
200 to 250 (8” to 10”)	65 (2½”)
≥ 300 (≥ 12”)	90 (3½”)

.5 Directional arrows shall be black stenciled 150mm (6”) long by 50mm (2”) wide for piping 75mm (3”) and larger, and 100mm (4”) long and 25mm (1”) wide for piping

65mm (2½”) and smaller. Double-headed arrows shall be used where the direction of flow is reversible

.6 Legend and directional arrows shall be applied on top of secondary color strip.

.7 Painting contractor to band all exposed or concealed piping except drainage piping and vent piping outside mechanical rooms, under the direction of Division 23 contractor, in the primary color listed in the Color Schedule. Paint bands to completely encircle the pipe for a length of 300mm (12”) in primary color.

.8 Piper markers shall conform to the following:

Outside Pipe Diameter (including covering) mm (in)	Minimum Length of Label Field Color mm (in)	Minimum Height of Letters mm (in)
20 to 30 (¾” to 1¼”)	200 (8”)	15 (½”)
40 to 50 (1½” to 2”)	200 (8”)	20 (¾”)
65 to 150 (2½” to 6”)	300 (12”)	30 (1¼”)
200 to 250 (8” to 10”)	600 (24”)	65 (2½”)
≥ 300 (≥ 12”)	800 (32”)	90 (3½”)

.9 Field color and lettering color are to be as per the Color Schedule.

.10 All bands shall be neatly arranged and in a straight line across groups of pipes.

.11 Identify piping runs at least once in each room. Do not exceed 15m (50 ft) between identifications in open areas.

.12 All bands, symbols, etc., are to be put in readily visible locations to be seen from floor level. Where piping is partially obscured by other piping and/or equipment, identify on both sides of obscuring equipment.

.13 Where piping passes through walls, partitions and floors, identify on both sides of where it enters and leaves.

.14 Division 23 contractor to apply stencil lettering only after the final finish has been applied.

.15 Where piping is concealed in pipe chase or other confined space, identify at points of entry and leaving and at each access opening.

.16 Identify piping at starting and end points of runs and at each piece of equipment.

.17 Identify piping at major manual and automatic valves immediately upstream of valves.

.18 Natural gas piping shall be painted yellow for the full length.

.19 Use white arrow on red background for fire protection.

.2 Identification Methods

.1 Exposed Piping in Mechanical Room

.1 Apply primary color to all piping in mechanical room in accordance with above requirements.

.2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.

.2 Concealed Piping

.1 No primary color coding required.

.2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.

.3 Lettering and Direction of Flow

.1 Lettering: Block capitals to sizes and colors listed in CAN/CGSB 24.3..

.2 For hazardous piping system: black letters and arrows.

.3 Fire protection, other piping systems and ductwork: white letters and arrows, unless otherwise specified.

.4 Pictograms

.1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.

.5 Miscellaneous

.1 Aluminum jacketed piping shall be identified the same as concealed piping.

.2 Exposed piping in service areas, other than mechanical rooms, shall be identified the same as concealed piping.

.3 Additional requirements for particular piping systems:

.1 Natural gas and propane gas:

1. Paint complete piping system yellow to CAN/CGAB149.1.
2. Apply legend and flow arrows after painting.

.2 Fire sprinkler system piping:

1. Provide system component signs to NFPA 13.

3.8 MANUFACTURER'S NAMEPLATES

.1 Provide a factory applied nameplate on each piece of manufactured equipment indicating size, equipment name, manufacturer's name, serial number, electrical characteristics and performance characteristics.

.2 Provide registration plates (such as pressure vessel, ULC and CSA approved plates as required by respective agency and as required by the specifications).

.3 Nameplates of non-Canadian made equipment shall include the name and address of the Canadian agent providing the product.

.4 Mechanically fasten nameplates securely in a conspicuous and easily read location.

.5 Do not apply insulation or paint over nameplates.

3.9 EQUIPMENT IDENTIFICATION

.1 The Division 23 contractor shall provide each piece of equipment with a lamacoid plate stating equipment name, system identification and equipment identification number. Lamacoid plates shall be a minimum 3mm thick with black letters on white background. Lettering to be:

  .1 Terminal cabinets and control panels: 8mm high lettering

  .2 Equipment in mechanical rooms and outdoors: 20 mm high lettering

  .3 Equipment located elsewhere: 12mm (½") high lettering

.2 Identify each piece of equipment with the symbol and number to be identified with record drawing equipment name and number.

.3 Equipment which is electrically driven and is identified shall have identical nameplates at the starter.

.4 All nameplates are to be mechanically fastened, easily visible without need to use a ladder or extraordinary body position. Affix additional nameplates if necessary.

.5 Provide the Engineer with an example of the contents of each type of nameplate. Obtain approval prior to engraving.

.6 Submit a complete schedule of all equipment to have identification and the symbol and description to be engraved on the lamacoid plates or stamped brass tags.

.7 Identify as a minimum the following with engraved plastic nameplates:

  .1 All mechanical equipment

  .2 VFDs

  .3 Electric starting switches, electric disconnects, remote push buttons and control panels.

3.10 VALVE IDENTIFICATION

.1 Division 23 contractor to provide 40mm (1½") diameter brass tags with 20mm (¾") engraved lettering and brass jack chain. Secure to items with brass hooks and non-ferrous chains or tie-wraps. Affix a tag to all valves or on piping directly adjacent to the valve.

.2 Valve tags are not required where valves are directly adjacent to the equipment they serve.

.3 Provide neat, typewritten valve location identification charts giving valve tag numbers, valve service and valve location, make/model/size with or without handwheel, type of control and normal position. Frame one copy in metal with acrylic face and mount in equipment room. Provide additional copies for inclusion in each operating and maintenance manual.

.4 Number valves in each system consecutively.

.5 Valve tags shall be provided as follows:

- .1 Tag pneumatic/electric controls, instruments and relays. Key to control schematic on which instruments are numbered in sequence.
- .2 Tag all valves in mechanical rooms.
- .3 Tag all control valves external to mechanical rooms. This includes control valves on radiant panels, perimeter radiation and air terminal boxes.
- .4 Tag all circuit balancing valves and isolating valves external to mechanical rooms except valves at terminal heating and cooling equipment.
- .5 Identify and tag thermostats and temperature sensors relating to terminal unit and valve numbers.

3.11 BUILDING MANAGEMENT SYSTEM IDENTIFICATION

.1 Utilize tags and nameplates as described for mechanical equipment and valves for automation system components.

.2 Use BMS mnemonics specified in BMS specification sections on tags and nameplates to identify BMS physical points and equipment.

.3 Identify each control element (freeze stats, humidistats, discharge temperature controllers, etc) with a laminated laser printed tag or an embossed metal band secured to each control element.

.4 Identify the following BMS components with laminated plastic nameplates:

- .1 Remote control unit (RCU) panels.
- .2 Subpanels.
- .3 Associated equipment panels.
- .4 Panel mounted valves; identify function of each valve.

3.12 ACCESS DOOR IDENTIFICATION

.1 Painting contractor to provide under the direction of the Division 23 contractor.

.2 Each access door for concealed equipment such as isolation valves, terminal boxes and coils shall be provided with stenciled number, minimum height shall be 20mm (¾”).

.3 Provide neat, typewritten directory giving access door number, service and location. Frame one copy under glass and mount in equipment room. Provide additional copies for inclusion in each operating and maintenance manual.

3.13 SITE PAINTING

.1 Treat exposed uninsulated ductwork with a coat of zinc chromate primer. Apply one (1) coat of anti-corrosive metal primer and two (2) coats of machinery enamel.

.2 Insulated exposed ductwork shall have one (1) coat of latex primer sealer and one (1) coat of flat latex.

.3 Air conditioning and ventilation units, tanks, other units with galvanized finish or stainless steel finish shall not be painted. Apply two (2) coats of machinery enamel to units with prime coat finish.

.4 Paint exposed piping. Finish exposed uninsulated pipes and drainage lines with one (1) coat of metal primer and two (2) coats of machinery enamel which shall be brushed out to a thin even coat, white in color or as selected by architect. Neutralize galvanized pipes with copper sulfate solution prior to painting. Insulated pipes shall have one (1) coat of latex primer sealer and one (1) coat of flat latex, milk white color. Do not paint aluminum jacketed piping except for identification.

.5 After all non-aluminum jacket piping is painted, the mechanical contractor shall direct the painting of color bands on all piping by the painting contractor. The Division 23 contractor shall stencil letters designating the pipe service and direction of flow. The symbol shall be finished in the color code of the mechanical specification.

.6 Steel grilles, diffusers and louvers that are primed only by the mechanical contractor shall have final painting carried out by the painter. Colors will be selected later by the architect from manufacturer’s standard range.

3.14 EQUIPMENT PROTECTION AND CLEAN-UP

.1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

3.15 PRE-PAINTED EQUIPMENT

.1 Division 23 Contractor to repair all pre-painted equipment that has been damaged or has faded.

3.16 EQUIPMENT BASES

.1 Equipment bases/housekeeping pads are to be painted grey with 100mm (1") yellow and black angled bands around the edges.

3.17 COLOR CODE SCHEDULE

.1 Color numbers for Identification Labels on piping systems, valves and equipment are defined in Federal Standard 595C Colors for color code identification

Mechanical Primary Colors for Pipe Lines/Equipment

Black	:	17038
Yellow	:	13591
Green	:	14193
Orange	:	12473
Brown	:	10115
Red	:	11350
White	:	17860
Aluminum	:	16515
Blue	:	15180
Grey	:	16293
Light Blue		15450
Purple		17155

.2 Identification Symbols and Colors for Piping

Fluid	Pipe Color	Lettering Color	WHMIS Symbol	Identification
Boiler Feed	Green	White	N/A	BOILER FEED
Chilled Water Supply	Green	White	N/A	CHWS
Chilled Water Return	Green	White	N/A	CHWR
Chilled Glycol Supply	Green	White	N/A	CHGS
Chilled Glycol Return	Green	White	N/A	CHGR
Condensate Drain	Green	White	N/A	
Fire Sprinkler Water	Red		N/A	
Fire Protection Water	Red		N/A	
Glycol Heating Supply	Green	White	Yes	GLYS
Glycol Heating Return	Green	White	Yes	GLYR
High Pressure Steam	Green	White	Yes	HPS
Low Pressure Steam	Green	White	Yes	LPS

Fluid	Pipe Color	Lettering Color	WHMIS Symbol	Identification
Natural Gas	Yellow	Black	Yes	NAT. GAS
Reverse Osmosis Water	Green	White	N/A	RO Water
Sprinkler	Red		N/A	

3.18 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

.3 Mechanical contractor coordination with balancing agency.

.4 Balance, adjust, and test air and liquid systems and equipment and submit reports using identical units to those shown on contract documents.

.5 Test operation of the fire dampers and combination fire/smoke dampers.

.6 Bring to the attention of the consultant, any items that are, in the opinion of the balancing agency, installed incorrectly, prior to commencement of balancing procedures.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1 Common Work Results for HVAC — Section 23 05 00

1.3 QUALITY ASSURANCE

.1 Work specified in this section shall be performed by an Independent Agency specializing in this type of work. Provide proof that the agency has successfully completed five projects of similar size and scope.

.2 List personnel, and their qualifications, who will be employed during the testing and balancing period. Provide documentation confirming qualifications, successful experience.

.3 Balancing air systems and liquid systems shall be performed by the same agency.

.4 TAB to be performed in accordance with the requirements and procedures of one of the following standards. The TAB standard used is to be noted in the balancing report.

  .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.

  .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

  .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.

.5 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.6 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.7 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.8 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.9 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

  .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

  .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 APPROVED AGENCIES

.1 Contractor to submit proposed agency for Consultant and Owner approval.

.2 Provide documentation confirming qualifications and previous experience with projects of similar size and complexity.

1.5 PURPOSE OF TAB

.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 and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.6 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.7 ACTION AND INFORMATION SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit, prior to commencement of TAB, a Preliminary TAB Report

  .1 Submit preliminary TAB report (balancing agenda) for checking and approval of the Departmental Representative at least sixty (60) days prior to the start of balancing work. Start balancing work only after agenda has been approved.

  .2 Include the following information.

.1 Descriptive Data:

.1 General description of each system to be balanced including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed.

.2 Procedure Data:

.1 Procedures for converting test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application (by sketch), correction factors and calculation procedures.

.3 Sample Forms

.1 Provide sample forms approved by the referenced standard. Forms are to include, but not be limited to, the following:

1. Air Moving Equipment Test Sheet.
2. Exhaust Fan Test Sheet.
3. Diffuser and Grille Test Sheet.
4. Water Balance Element Test Sheet.
5. Circulating Water Pump Data Sheet.
6. Duct Traverse Zone Totals Sheet.
7. Duct Traverse Readings Sheet.

.3 TAB Report

.1 Submit PDF copy of TAB Report to Departmental Representative for verification and approval, in English. PDF report to have bookmarks for each section.

.2 Format in accordance with referenced standard.

.3 General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed.

.4 Procedure Data: Procedures for converting test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

.5 Balance Reports:

.1 Submit copies of reports described prior to final acceptance of project. Provide copies for the consultant and for inclusion in Operating and Maintenance Manuals.

.2 Provide reports in soft-cover, three-ring binder manuals, complete with index page and indexing tabs and cover identification at front and side.

.3 Stamp reports by a registered professional engineer certifying adherence to agenda, calculation procedure and final summaries.

.4 Include types, serial number and dates of calibration of instruments.

.6 System Data Reports:

.1 Reports shall include balance and equipment data listed. Report all values in units identical to those specified and shall be shown for design values and actual measured values.

.2 Include schematic diagrams of systems showing final valve, damper and component location and positioning.

.3 Report design and final observed air and water capacities, velocities, etc., including outside air and return air volumes at various damper positions.

.4 Report air temperatures at various mixing damper positions, at inlet and outlet of all heat transfer equipment and at supply terminals.

.5 Report water and glycol temperatures at various mixing valve positions, at inlet and outlet of all heat transfer equipment.

.6 Report static pressure readings at various system operating conditions showing total static, duct static, etc.

.7 Report equipment characteristics at various system operating conditions including, but not limited to, motor name-plate data and actual RPM, adjustable sheave position, fan inlet velocity, filter pressure drop, fan pitch angle, calculation factors for air terminals, etc.

1.8 CLOSEOUT SUBMITTALS

.1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 – Closeout Submittals.

.2 Provide four (4) copies of final reports to contractor for inserting in Owner's Operating and Maintenance Manuals as described in Section 23 05 00 – Common Work Results for HVAC.

1.9 MECHANICAL CONTRACTOR RESPONSIBILITIES

.1 Bring the work to an operating state and ready for balancing, including:

.1 Clean equipment and ductwork.

.2 Install air terminal devices.

.3 Provide temporary filters in air handling equipment and carry out a rough air balance to ensure all equipment performs required function.

.4 Replace filters with specified filters prior to final balancing.

.5 Verify lubrication of equipment.

.6 Install permanent instrumentation.

.7 Clean piping systems as per Section 23 08 16 – Cleaning and Start-Up of Mechanical Piping Systems. Drain and fill systems with clean, treated heat exchange fluid.

.8 Complete the "start-up" of equipment.

.9 Review packing and seals on all pumps and valves.

.10 Ensure all strainers are clean and complete prior to fluid system balancing.

.11 Check rotation and alignment of rotating equipment and tension of belted drives.

.12 Set control points of automatic apparatus, check-out sequence of operation.

.13 Make available control diagrams and sequence of operation.

.14 Clean work, remove temporary tags, stickers, and coverings.

.15 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

.16 Provide Balancing Agency a complete set of mechanical drawings and specifications.

.2 Cooperate with the Balancing Agency as follows:

.1 Make corrections as required by Balancing Agency.

.2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of record drawings for their use.

.3 Provide and install any additional balancing valves, dampers, and other materials requested by the balancing agency and/or necessary to properly adjust or correct the systems to design flows.

.4 Provide and install revised pulleys and sheaves for rotating equipment and shave pump impellers, as required to properly balance the systems to design flows. Obtain requirements from balancing agency.

.5 Operate automatic control system and verify set points during Balancing.

1.10 COORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.11 PRE-TAB REVIEW

.1 Review Contract Documents before project construction is started confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.12 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.13 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

- .1 Installation of ceilings, doors, windows, other construction affecting TAB.
- .2 Application of weather stripping, sealing, and caulking.
- .3 Pressure, leakage, other tests specified elsewhere Division 23.
- .4 Provisions for TAB installed and operational.

.3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Proper thermal overload protection in place for electrical equipment.
- .3 Air systems:
  - .1 Filters in place, clean.
  - .2 Duct systems clean.
  - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
  - .4 Correct fan rotation.
  - .5 Fire, smoke, volume control dampers installed and open.
  - .6 Coil fins combed, clean.
  - .7 Access doors, installed, closed.
  - .8 Outlets installed, volume control dampers open.

.4 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.14 SITE VISITS

.1 Total of 2 site visits shall be made during the construction period. After each site visit, a written report shall be submitted to the Contractor and Engineer. Site visits shall commence after the start of air and liquid distribution work and be spread over the construction period to the start of the balancing work.

.2 A review of the installation and access to all valves, dampers, and equipment shall be made at the specified site visits and any additional dampers or valves required for proper balancing shall be forwarded in writing to be reviewed by the Engineer.

.3 Allow for 2 visits of 2 days to site to adjust systems for seasonal changes during warranty. Coordinate time of visits with the Owner. Submit reports to Engineer.

1.15 POST OCCUPANCY TAB

.1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

1.16 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.17 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.18 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.19 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.20 SYSTEM DATA

.1 Standard: TAB to most stringent of referenced TAB standard, SMANCA or ASHRAE.

.2 Air Handling Equipment

- .1 Design Data:
  - .1 Total air flow rate;
  - .2 Fan total static pressure;
  - .3 System static pressure;
  - .4 Motor kW (HP), r/min, amps, Volts, Phase;
  - .5 Outside air flow rate L/s (cfm);
  - .6 Fan r/min;
  - .7 Fan/kW (HP);
  - .8 Inlet and outlet, dry and wet bulb temperatures.
- .2 Installation Data:
  - .1 Manufacturer and model;
  - .2 Size;
  - .3 Arrangement discharge and class;
  - .4 Motor type, kW (HP), r/min, voltage, phase, cycles, and load amperage;
  - .5 Location and local identification data.
- .3 Recorded Data:
  - .1 <u>Supply Air Fan</u>
    - .1 <u>Fan @ 100% Outside Air</u>
      1. Air flow rate;
      2. Fan total static pressure;

3. System static pressure;

.2 <u>Fan @ Full Return/Min O/A</u>

1. Air flow rate;
2. Fan total static pressure;
3. System static pressure;

.2 <u>Return Air Fan</u>

.1 <u>Fan @ 100% Exhaust Air</u>

1. Air flow rate;
2. Fan total static pressure;
3. System static pressure;

.2 <u>Fan @ Full Return</u>

1. Air flow rate;
2. Fan total static pressure;
3. System static pressure;

.3 Fan rpm;

.4 For Axial Fans, note blade pitch angle

.5 Motor operating amperage;

.6 Inlet and outlet, dry and wet bulb temperatures.

.3 Duct Air Quantities - All mains supplying more than 10% of Volume, outside air and exhaust (maximum and minimum) major return air openings back to duct shafts.

.1 Duct sizes;

.2 Number of pressure readings;

.3 Sum of velocity measurements;

.4 Average velocity;

.5 Duct recorded air flow rate;

.6 Duct design air flow rate.

.4 Air Inlet and Outlets:

.1 Outlet identification location and designation;

.2 Manufacturers catalogue identification and type;

.3 *Application factors;

.4 Design and recorded velocities;

.5 Design and recorded air flow rates;

.6 Deflector vane or diffuser cone settings.

.5 Pumps (Including DHWR pump & domestic water booster system)

.1 Design Data

.1 Fluid flow rate;

.2 Total Head;

.3 r/min;

.4 kW (HP), r/min, amps, volts, phase.

.2 Installation Data

.1 Manufacturer and model;

.2 Size;

.3 Type drive;

.4 Motor type, kW (HP), r/m, voltage, phase, and full load amperage.

.3 Recorded Data:

.1 Discharge and suction pressures with secondary systems on both bypass and full circulation (full flow and no flow);

.2 Operating head;

.3 Operating water flow rate (from pump curves if metering not provided);

.4 Motor operating amps (full flow and no flow);

.5 r/min.

.6 Air Heating and Cooling Equipment

.1 Design Data:

.1 Heat transfer rate;

.2 Liquid and air flow rates;

.3 Liquid pressure drop;

.4 Air static pressure drop;

.5 Entering and leaving liquid temperatures;

.6 Entering and leaving air dry and wet bulb temperatures.

.2 Installation Data:

.1 Manufacturer, model, type;

.2 Entering and leaving fluid flow and temperatures;

.3 Entering and leaving air flow and temperatures;

.4 Fluid and air side pressure drops.

.3 Recorded Data:

.1 Element type and identification (location and designation);

.2 Entering and leaving air dry and wet bulb temperatures;

.3 Entering and leaving water temperatures;

.4 Liquid pressure drop;

.5 Air static pressure drop;

.6 Air and Liquid flow rates;

.7 Adjusted temperature rise or drop.

.7 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.8 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

Part 2 Products

Not used.

Part 3 Execution

3.1 GENERAL PROCEDURE

.1 Permanently mark, by stick-on labels and/or fluorescent paint, settings on valves, splitters, dampers, and other adjustment devices.

.2 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.

.3 Where vane anemometer is used to measure supply, return or exhaust air grilles, AK factors shall be determined as follows:

.1 Determine and tabulate similar sized grilles being balanced for AK schedule.

.2 Traverse all ducts serving grilles (outlined in AK schedule) to verify AK factors.

.3 AK factor from schedule must be approved by Engineer during initial review with balancer on site. (Balancer shall include written procedure for determination of AK factors).

.4 No flow hoods are to be used for measurement of exhaust or return air grilles.

.4 Balancing shall be performed to the following accuracies:

.1 Air - terminal outlets ±10% (outlets less than 200 L/s (425 CFM))

.2 Air - terminal outlets ±5% (outlets greater than 200 L/s (425 CFM))

.3 Air - central equipment ±5%

.4 Hydronic - terminal outlets ±10%

.5 Hydronic - pumps and central ±5%

.5 Balancing contractor shall advise mechanical contractor of required revised pulleys, sheaves and impeller shavings to allow proper balancing of systems.

.6 Where pump impellers require shaving, this shall be the responsibility of the mechanical contractor. All adjustments shall be by qualified millwright. All changes shall be documented and included as part of the balancing report.

.7 Check and adjust entire system approximately six months after final acceptance. Adjust system if deviations have occurred since balance report acceptance. Submit report.

.8 The work shall also include the following:

  .1 Setting of all pressure regulating and reducing valves to operating and code conditions.

  .2 Check and setting of all relief and safety valves to code requirements.

  .3 Balancing of all water flows to coils, etc., to design conditions.

  .4 Setting of all pump discharge volumes to design conditions.

  .5 Balancing of all air flows from fans in ducts, through air outlets and reheat coils to design conditions.

.9 Test the operation of each fire damper and fire/smoke damper.

3.2 GENERAL HEAT TRANSFER SYSTEM BALANCING

.1 Balance flow through all heat transfer equipment to give the specified temperature drop at correct entering conditions. Record air entering and leaving temperatures. Record water flow rates and temperatures.

.2 Adjust flow through pumps with globe valves. If necessary, trim or replace impeller to provide proper flow.

.3 Adjust all pumps and valves necessary to provide specified pressure drops through equipment and pipe lengths.

.4 Adjust flows with automatic valves fully open.

3.3 GENERAL AIR SYSTEM BALANCING

.1 All new air systems to be balanced to show air volumes and velocities at main and branch ducts and at all terminals. Fan volumes to be recorded at various mixed air conditions.

.2 Record system air temperatures at various mixed air conditions.

.3 Adjust air flow and terminals to eliminate objectionable air noise at terminal.

.4 Use Pitot tube transverse across entire duct area to measure air flow.

.5 Vary total air system quantities by adjustment of fan speeds.

.6 Where modulating dampers are installed, take measurements at both high and low extremes.

.7 Balance variable volume system to maximum air flow rate with full cooling flow and to minimum air flow rate with full heating flow.

.8 Perform balancing, adjusting, and testing with building doors and windows in their normal operation position.

.9 The following procedure shall be adopted for central systems:

.1 Ensure dampers or volume control devices are in fully open position.

.2 Balance central apparatus to ±5% air flow.

.3 Balance branches and mains in accordance with 3.1.4.

.4 Recheck central apparatus.

.5 Balance all terminal air outlets in accordance with 3.1.4.

.6 Re-balance central apparatus to ±5%.

.7 Recheck all air outlets.

.8 Perform acoustical measurements.

.10 When balancing air outlets:

.1 Rough balance furthest outlets and then balance sequentially back to source.

.2 Fine balance furthest outlet back to source.

.11 Take static pressure readings and air supply temperature readings at 10 points on the system.

.12 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. Take a minimum of 16 for rectangular ducts, and 10 on each vertical and horizontal axis for round ducts, traverse readings. If readings are inconsistent across duct, try to obtain straight run of six (6) diameters widths upstream and re-do traverse.

3.4 FIRE DAMPER/FIRE STOP FLAP VERIFICATION

.1 Visually inspect all fire dampers and fire stop flaps:

.1 Installation is straight.

.2 Wall angles properly installed.

.3 Duct has break away connection.

.4 Fire stopping material where used is properly installed.

.5 Adequate access.

.6 Clearance between sleeve and wall.

.2 Inspect all fire damper blades and tracks prior to test firing. Sheet metal trade to clean all dirty dampers and tracks to satisfaction of balancer.

.3 Manually remove each fusible link to ensure damper blade drops properly, then reset damper. Mark dropped fire damper with black felt marker.

.4 Testing of 10% of the fusible links shall be performed with a suitable heat source capable of generating sufficient heat to detonate fusible link without burning or generating carbon deposits on the blades, frame or adjacent ductwork. Selection of links to be test dropped to be as directed by Engineer. Retesting and resetting shall be witnessed by Engineer.

.5 If fire damper does not close properly, sheet metal trade to repair installation and balancing agency to retest.

.6 All fire damper tests shall be witnessed by two parties, certified by Contractor and endorsed by the testing personnel.

.7 Contact Alberta Building Code enforcement authorities in writing prior to testing each damper and have authorities witness tests as required.

3.5 BALANCING OF HYDRONIC SYSTEMS

.1 Open all (excepting pressure bypass must be closed) valves to fully open position including balancing valves, isolation valves, and control valves.

.2 Execute air balance prior to initiating hydronic balance (if coils are provided).

.3 Remove temporary strainers and install permanent sheaves prior to commencing balancing of hydronic systems (Refer to Section 23 05 92, Coordination With Balancing Agency).

.4 Set pumps to deliver 10% excess flow if possible.

.5 Adjust flows through each boiler or chiller to ensure equal flow.

.6 Check and adjust flows and temperatures at inlet side of coils.

.7 Position and mark all automatic valves, hand valves and balancing cocks for design flow through all coils, connectors, and all items in system requiring circulation of liquid.

.8 Upon completion of flow readings and coil adjustments, mark setting and record data.

.9 Coordinate with the mechanical contractor shaving of impeller to operating condition on pumps larger than 1.5 kW (2 HP).

.10 Ensure all bypass valves are tightly closed.

.11 After making all terminal unit adjustments, re-check settings at pumps. Re-adjust as required.

.12 Calibrate all pressure and temperatures gauges.

.13 For all parallel pumping systems, check all flows through boilers, chillers, heat exchangers, and pumps under the following situations:

.1 With two pumps operating.

.2 With one pump operating - repeat for each pump.

.3 With controls demanding no heating or cooling.

.14 For each pump, plot maximum and minimum flows on curve.

.15 Verify pressure drops and flows through 3-way pressure control bypass valves at full operating range.

.16 Perform water systems balancing for each water system as per AABC specifications as described in the following.

3.6 BALANCING REPORT

.1 Submit draft copies of rough balancing reports prior to final acceptance of project.

.2 Include types, serial number and dates of calibration of instruments.

.3 Record test data on a sepia made from the latest available revised set of mechanical drawings and submit three (3) copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals.

.4 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Materials and methods for pressure testing ducts over 5m (16 ft) in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Metal Ducts – Low Pressure to 500 kPa	Section 23 31 13.01
.3	Air Duct Accessories	Section 23 33 00
.4	HVAC Fans	Section 23 34 00
.5	Louvers, Intakes and Vents	Section 23 37 20

1.3 REFERENCE STANDARDS

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

  .1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

  .1 SMACNA HVAC Air Duct Leakage Test Manual

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Test Reports: Submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:

  .1 Submit proposed report form and test report format to Departmental Representative for approval at least one (1) month before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

  .2 Prepare report of results and submit to Departmental Representative within two (2) working days of completion of tests. Include:

    .1 Schematic of entire system.

    .2 Schematic of section under test showing test site.

    .3 Required and achieved static pressures.

    .4 Orifice differential pressure at test sites.

.5 Permissible and actual leakage flow rate (L/s) for test sites.

.6 Witnessed certification of results.

.3 Include test reports in final TAB report.

Part 2 Products

2.1 TEST INSTRUMENTS

.1 Test apparatus to include:

.1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within ±3% of flow rate and pressure.

.3 Submit details of test instruments to be used to Departmental Representative at least one (1) months before anticipated start date.

.4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.

.5 Re-calibrated every six (6) months thereafter.

Part 3 Execution

3.1 DUCTWORK TESTS

.1 Refer to Section 23 05 00 – Common Work Results for HVAC for system testing and start-up requirements.

.2 All ductwork, regardless of service shall be subjected to pressure tests with costs borne under the mechanical construction contract. All duct sections are to be tested except as approved by the consultant.

.3 Equivalency of duct quality testing may be granted to the contractor on the following basis, at the consultant’s discretion:

.1 The contractor submits to the consultant and obtains approval of a quality control process for ductwork testing.

.2 For each duct system (low and high pressure) test one main length for each of, supply, return and/or exhaust air for establishment of base-line quality.

.3 If defects are recorded, or if any duct section fails the test procedure established, which, in the opinion of the consultant, are serious, the consultant may request further duct testing to a maximum of 100% of all ductwork joints at his discretion. The contractor shall bear all related costs of the extra testing procedures as an acknowledgement of maintenance of project quality requirements.

.4 All low pressure ductwork: Leak test at 1½ times the actual working pressure, but no less than 750 Pa (3" WG). Leakage shall be inaudible and not detectable by feel and not to exceed allowable leakage noted in Section 3.3 in the section tested.

.5 High and medium pressure duct: Test in sections of no more than complete floors. Test to a static pressure of 1½ times the actual working pressure, but no less than 2.0 kPa (8" WG). Leakage shall be inaudible and is not to exceed allowable leakage noted in Section 3.3 in the section tested.

.6 Testing to be completed before any ductwork is concealed or covered.

3.2 TEST PROCEDURES

.1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.

.2 Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.3 Close off open end of all take-offs (except one) with suitable plugs or cap;

.4 Attach pressure kit to open take-off;

.5 Rise duct static pressure and hold by adjusting blower inlet area;

.6 Measure leakage by manometer reading across orifice plate, reading shall not exceed 0.25 kPa (1" WG).

.7 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.8 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.9 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 DUCT LEAKAGE

.6 Duct leakage allowance to be the more stringent between the SMACNA HVAC Air Duct Leakage Test Manual and the table noted below.

.7 The maximum permitted leakage shall be calculated as follows:

$$L_{max} = (C_L \cdot (P)^{0.65}) / 720$$

Where:

L_{max} = Maximum permitted leakage, in L/s/100m^2 of duct surface area.

C_L = Leakage class from Section 2.1.1.

P = Maximum operating static pressure, Pa

.8 Leakage Classes Schedule

Shape of Duct	**Maximum Operating Static Pressure, Pa**		
	< 500	**500-750**	**> 750**
	C_L		
Rectangular	24	12	6
Round	12	6	3

.1 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

.4 Flexible connections to VAV boxes.

3.5 CLEANING

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

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Duct thermal insulation

.2 Duct acoustic insulation

.3 Breeching insulation

.4 Adhesives, tie wires, tapes

.5 Recovery materials

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	HVAC Piping Insulation	Section 23 07 15

1.3 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1	ANSI/ASHRAE/IESNA 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials (ASTM)

.1	ASTM B209M	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
.2	ASTM C335	Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
.3	ASTM C411	Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
.4	ASTM C449/C449M	Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
.5	ASTM C547	Standard Specification for Mineral Fiber Pipe Insulation.
.6	ASTM C553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
.7	ASTM C612	Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795 — Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921 — Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-51.9 — Mineral Fiber Thermal Insulation for Piping and Round Ducting

.2 CAN/CGSB-51.10 — Mineral Fibre Board Thermal Insulation

.3 CAN/CGSB-51.11 — Mineral Fibre Thermal Insulation Blanket

.4 CAN/CGSB-51.12-M86 — Thermal Insulating and Finishing Cement

.5 CAN/CGSB-51.53 — Poly (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels and Round Ducts

.6 CGSB 51-GP-52Ma — Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation

.4 National Fire Protection Association (NFPA):

.1 NFPA 255 — Standard Method of Test of Surface Burning Characteristics of Building Materials

.5 National Research Council of Canada

.1 National Energy Code of Canada for Buildings 2017 (NECB).

.6 Thermal Insulation Association of Canada (TIAC)

.1 Mechanical Insulation Best Practices Guide.

.7 Underwriters Laboratories Canada (ULC)

.1 CAN/ULC-S102 — Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701 — Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.4 DEFINITIONS

.1 For the purposes of this Section, the following definitions apply:

.1 Concealed: Ductwork in trenches, shafts, furring, and suspended ceilings.

.2 Exposed: Ductwork in mechanical rooms or otherwise not "concealed".

.3 Insulation systems: insulation material, fasteners, jackets, and other accessories.

.4 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.5 QUALITY ASSURANCE

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of work and have at least three (3) years experience in this size and type of project.

.2 Materials shall meet fire and smoke hazard ratings as stated in this section and defined in applicable building codes.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.

.3 Shop Drawings

.1 For each application submit an insulation schedule to include the following information:

.1 Materials

.2 "k" value

.3 Thickness

.4 Density

.5 Flame/smoke development ratings

.6 Finish

.7 Jacketing

.2 Submit information showing installed insulation and membrane products meet the requirements of the NECB and ASHRAE 90.1.

.2 Submit documentation for adhesives and sealants including printed statement of VOC content.

.4 Manufacturer’s Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations. special handling criteria, installation sequence, and cleaning procedures.

1.7 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Product Data:

.1 Refer to shop drawing requirements above.

1.8 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 Flame proofing treatments subject to deterioration due to the effects of moisture or high humidity are not acceptable.

.2 All adhesives, sealers, vapor coatings, etc., shall be compatible with the materials to which they are applied and shall not deteriorate insulation material.

.3 All insulation materials shall meet Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.2 Products shall not contain asbestos, lead, mercury, or mercury compounds.

.3 Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

.4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

.5 Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 FLAME/SMOKE DEVELOPMENT RATINGS

.1 Insulation materials, recovery materials, vapor barrier facings, tapes and adhesives shall have maximum flame spread rating of 25 and maximum smoke developed rating of 50, when tested in accordance with CAN/ULC-S102. Materials required which do not meet this rating must be treated on site with finish which will provide necessary ratings.

.2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C411.

.3 ULC or ULI label or listing or satisfactory certified report form an approved testing laboratory will be required to indicate that the fire hazard ratings for materials proposed for used do not exceed those specified.

2.3 INSULATION

.1 Mineral fiber: as specified includes glass fiber, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335 TIAC Code C-1: Rigid Mineral Fiber Board to ASTM C612, with or without factory applied vapor retarder jacket to CGSB 51-GP-52Ma.

.3 TIAC Code C-2: Mineral Fiber Blanket to ASTM C553 Faced with or without Factory Applied Vapor Retarder Jacket to CGSB 51-GP-52Ma.

- .1 Mineral fiber: to ASTM C553.
- .2 Jacket: to CGSB 51-GP-52Ma.
- .3 Maximum "k" factor: to ASTM C553.

.4 Insulation on cold ducts to be complete with factory applied vapor retarder jacket.

2.4 JACKETS MATERIALS

.1 Canvas:

- .1 ULC listed 220 gm/m^2 (6.4 oz/yd^2) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: Compatible with insulation.

.2 Aluminum:

- .1 To ASTM B209 with or without moisture barrier.
- .2 Thickness: 0.50mm (0.02”) sheet.
- .3 Finish: Smooth or stucco embossed
- .4 Jacket banding and mechanical seals: 20mm (¾”) wide, 0.5mm (0.02”) thick stainless steel.

2.5 ACOUSTIC DUCTWORK INSULATION

.1 Material: Rigid mineral fiber acoustical insulation to ASTM C1071, Type 2

.2 Density: 48 kg/m³ (3 lb/ft³) (minimum)

.3 Acoustic Properties: Minimum NRC of 0.70 for 25mm (1”) thickness based on Type A mounting to ASTM C423

.4 "k" Value: maximum 0.035 W/m°C at 24°C (0.24 btu in/hr/ft2 at 75°F) when tested in accordance with ASTM C177

.5 Service Temperature: -40°C to 65°C (-40°F to 150°F)

.6 Surface Finish: Absolute roughness of exposed surface not to exceed 0.58mm (26 gauge), coated to prevent fibre erosion at air velocities up to 25.4 m/s (5000 ft/m)

2.6 BREECHING INSULATION

.1 Material: Semi-rigid mineral fibre with glass mat.

.2 "k" Value: Maximum 0.035 W/m°C at 24°C (0.24 btu in/hr/ft2 maximum at 75°F)

.3 Service Temperature: 65°C to 450°C (150°F to 840°F)

2.7 ACCESSORIES

.1 Vapor retarder lap adhesive:

  .1 Water based, fire retardant type, compatible with insulation.

.2 Indoor Vapor Retarder Finish:

  .1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: Hydraulic setting on mineral wool, to ASTM C449.

.4 Tape: self-adhesive, aluminum, reinforced, 50mm (2”) wide minimum.

.5 Contact adhesive: quick-setting

.6 Canvas adhesive: washable.

.7 Tie wire: 1.5mm (0.06”) diameter stainless steel.

.8 Banding: Stainless steel, 19mm (¾”) wide, 0.5mm (0.02”) thick.

.6 Facing: 25mm (1”) galvanized steel hexagonal wire mesh on both faces of insulation.

.7 Fasteners: Welding pins 4mm (0.15”) diameter shaft with 35mm (1½”) diameter head for installation through the insulation. Length to suit thickness of insulation with 35mm (1½”) square nylon retaining clips.

Part 3 Execution

3.1 JOB CONDITIONS

.1 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement, poor workmanship, or material defects.

3.2 PRE-INSTALLATION

.8 Pressure testing of ductwork systems and adjacent equipment to be complete, witnessed and certified.

.9 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions, where possible.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards and manufacturer’s recommendations.

.10 Use two layers with staggered joints when required nominal wall thickness exceeds 75mm (3”).

.2 Ensure insulation is continuous through floor and wall sleeves etc. Pack around piping and ducts with fireproof self-supporting insulation materials, properly sealed.

.3 A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation and cold surfaces for which vapor seal is specified.

.4 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

  .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.5 Fasteners: install at 300mm (12”) on center in horizontal and vertical directions, minimum 2 rows each side.

.6 Install insulation at ambient temperatures within acceptable temperature ratings for tapes, sealants and adhesives.

.7 Apply insulation to provide smooth and even finish, uniform diameter, no sagging, wrinkling, etc.

.8 Do not insulate ductwork with external thermal insulation where acoustic duct insulation is specified or indicated.

.9 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.

.10 Ductwork carrying outside air must be insulated completely so there is no break in either the insulation thickness or vapor barrier.

.11 Insulated in their entirety are all emergency generator ventilation ductwork, all combustion air ductwork, relief air ductwork (ductwork from air handling units to exterior walls or openings), all exhaust air ductwork for a distance of 5m (16 ft) from the exterior walls or openings, ductwork carrying hot or cold conditioned air and outside air ductwork.

.12 Unless otherwise indicated, do not insulate ducts carrying air at room ambient temperature, exhaust air ductwork except as noted above, return air ductwork, and ductwork fitted with an approved acoustic thermal lining.

.13 Where duct velocities exceed 10m/s (2000ft/m), cover insulation with 0.8mm perforated galvanized steel with 24% free area.

.14 Locate insulation or cover seams in least visible locations. Locate seams on ductwork in ceiling spaces on the underside of the duct.

.15 Stagger butt joints where multi-layered insulation is used.

.16 Butt duct insulation at top of duct. Stagger all joints where more than one layer of insulation is used. Tape all insulation joints neatly.

3.4 ACOUSTIC DUCT INSULATION APPLICATION

.1 Do work in accordance with the recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.

.2 Install in accordance with manufacturer’s recommendations, and as follows:

  .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.

  .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425mm (17”) on centers.

.3 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer’s written recommendations, and as follows:

  .1 Bed tape in sealer.

  .2 Apply two coats of sealer over tape.

.4 Replace damaged areas of liner at discretion of the Engineer.

.5 Protect leading and trailing edges of duct sections with sheet metal nosing having 15mm (½”) overlap and fastened to duct.

3.5 PLENUM WALL INSULATION

.1 For all plenum walls on the interior of the building that are exposed to exterior conditions, including outside air and exhaust air plenums, insulate with 100mm (4”) insulation between sheet metal walls. Foil facing is not necessary where sheet metal acts as vapor barrier.

3.6 BREECHING INSULATION APPLICATION

.1 Face breeching with 9.5mm (0.37”) rib lath turn out to provide 12 mm space between insulation and hot surface and 12.5mm (½”) mesh expanded lath on the outside.

.2 Butt insulation firmly together and secure with 1.6mm (0.06”) galvanized wire.

.3 Lace metal mesh together. Coat with 12mm (½”) thick finishing cement. Finish with a final 12mm (½”) coat of finishing cement with 25% by weight of Portland cement. Trowel to a smooth hard finish.

.4 Recover with aluminum jacket. Fasten aluminum recovery jacket in place with 12mm (½”) wide stainless steel banding on 300mm (12”) centers or screws or rivets on 150mm (6”) centers. Lap longitudinal slip joints by 50mm (2”).

3.7 INSULATION SCHEDULE – DUCTING

Temperature Difference (1) °C (°F)	**Min. Thermal Resistance of Ducts & Plenums m²·°C/W ((hr·ft²·°F)/Btu)**	**Min. Thermal Resistance of Runouts (2) m²·°C/W ((hr·ft²·°F)/Btu)**
< 5 (9)	0	0
5 to 22 (9 to 40)	0.58 (3.3)	0.58
≥ 22 (40)	0.88	0.58

Notes:

1) Temperature difference at design conditions between the space within which the duct is located and the design temperature of the air carried by the duct.

2) Refers to ducts not exceeding 3m (10 ft) in length that connect to terminal grilles or diffusers.

Ducts	**Min. Thermal Resistance m²·°C/W ((hr·ft²·°F)/Btu)**	Insulation Thickness mm (in)	Recovery Jacket
Ducts – Acoustic	–	25 (1”) (unless indicated otherwise)	–
Ducts – Combustion Air	0.88	50 (2”)	Canvas

Ducts	**Min. Thermal Resistance $m^2 \cdot °C/W$ $((hr \cdot ft^2 \cdot °F)/Btu)$**	Insulation Thickness mm (in)	Recovery Jacket
Ducts – Exhaust (within 3m (10’-0”) of exterior walls or openings)	0.88	50 (2”)	Canvas
Ducts – Outside Air	0.88	50 (2”)	Canvas
Ducts – Relief Air	0.88	50 (2”)	Canvas
Ducts – Supply Air (with cooling coil)	0.58	25 (1”)	Canvas
Ducts – Supply Air Runouts (1) (with cooling coil)	0.58	25 (1”)	Canvas
Plenums – Exhaust Air	0.88	100 (4”)	Canvas
Plenums – Outside Air	0.88	100 (4”)	Canvas
Plenums – Supply Air (with cooling coil)	0.58	50 (2”)	Canvas

Notes:

1) Refers to ducts not exceeding 3m (10 ft) in length that connect to terminal grilles or diffusers.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Heating & humidification systems: (steam, steam condensate, heating hot water, heating glycol) ambient up to 232°C (450°F)

.2 Adhesives, tie wires, tapes

.3 Recovery materials

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Duct Insulation	Section 23 07 13

1.3 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1	ANSI/ASHRAE/IESNA 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials (ASTM)

.1	ASTM B209M	Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate [Metric].
.2	ASTM C335	Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
.3	ASTM C411	Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
.4	ASTM C449/C449M	Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
.5	ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation.
.6	ASTM C547	Mineral Fiber Pipe Insulation.
.7	ASTM C795	Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921 — Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-51.2 — Thermal Insulation, Calcium Silicate for Piping, Machinery and Boilers

.2 CAN/CGSB-51.9 — Mineral Fiber Thermal Insulation for Piping and Round Ducting

.3 CAN/CGSB-51.11 — Mineral Fibre Thermal Insulation Blanket

.4 CAN/CGSB-51.12-M86 — Thermal Insulating and Finishing Cement

.5 CAN/CGSB-51.53 — Poly (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels and Round Ducts

.6 CGSB 51-GP-52Ma — Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.5 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.6 National Fire Protection Association (NFPA):

.1 NFPA 255 — Standard Method of Test of Surface Burning Characteristics of Building Materials

.7 National Research Council of Canada

.1 National Energy Code of Canada for Buildings 2017 (NECB).

.8 Thermal Insulation Association of Canada (TIAC)

.1 Mechanical Insulation Best Practices Guide.

.9 Underwriters Laboratories Canada (ULC)

.1 CAN/ULC-S102 — Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701 — Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702 Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2 Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.4 QUALITY ASSURANCE

.3 Insulation shall be installed by skilled workmen regularly engaged in this type of work and have at least three (3) years experience in this size and type of project.

.4 Materials shall meet fire and smoke hazard ratings as stated in this section and defined in applicable building codes.

.1 Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

.2 Coordinate installation and testing of heat tracing.

1.5 DEFINITIONS

.1 For the purposes of this Section, the following definitions apply:

.1 Concealed: Piping in trenches, shafts, furring, and suspended ceilings.

.2 Exposed: Piping in mechanical rooms or otherwise not "concealed".

.3 Insulation systems: insulation material, fasteners, jackets, and other accessories.

.4 TIAC Codes:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.

.3 Shop Drawings

.1 For each application submit an insulation schedule to include the following information:

.3 Materials

.4 "k" value

.5 Thickness

.6 Density

.7 Flame/smoke development ratings

.8 Finish

.9 Jacketing

.2 Submit information showing installed insulation and membrane products meet the requirements of the NECB and ASHRAE 90.1.

.3 Submit documentation for adhesives and sealants including printed statement of VOC content.

.5 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations. special handling criteria, installation sequence, and cleaning procedures.

1.7 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Product Data:

.1 Refer to shop drawing requirements above.

1.8 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 Flame proofing treatments subject to deterioration due to the effects of moisture or high humidity are not acceptable.

.2 All adhesives, sealers, vapor coatings, etc., shall be compatible with the materials to which they are applied and shall not deteriorate insulation material.

.3 All insulation materials shall meet Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.4 Products shall not contain asbestos, lead, mercury, or mercury compounds.

.5 Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

.6 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

.7 Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 FLAME/SMOKE DEVELOPMENT RATINGS

.1 Insulation materials, recovery materials, vapor barrier facings, tapes and adhesives shall have maximum flame spread rating of 25 and maximum smoke developed rating of 50, when tested in accordance with CAN/ULC-S102. Materials required which do not meet this rating must be treated on site with finish which will provide necessary ratings.

.2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C411.

.3 ULC or ULI label or listing or satisfactory certified report form an approved testing laboratory will be required to indicate that the fire hazard ratings for materials proposed for used do not exceed those specified.

2.3 INSULATION

.1 Mineral fiber specified includes glass fiber, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335.

.3 Factory applied vapor retarder jacketing is to be provided on insulation installed on the following piping systems:

 .1 Domestic cold water

 .2 Chilled water / glycol

 .3 Sanitary vents

.4 TIAC Code A-1: Rigid Molded Mineral Fiber without Factory Applied Vapor Retarder Jacket

 .1 Mineral fiber: to CAN/ULC-S702

 .2 Maximum "k" factor: As noted in Insulation Schedule

.5 TIAC Code A-3: Rigid Molded Mineral Fiber with Factory Applied Vapor Retarder Jacket

.1 Mineral fiber: to CAN/ULC-S702

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: As noted in Insulation Schedule

.6 TIAC Code C-2: Mineral Fiber Blanket Faced with or without Factory Applied Vapor Retarder Jacket

.1 Mineral fibre: to CAN/ULC-S702.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: As noted in Insulation Schedule

.7 TIAC Code A-6: Flexible Unicellular Tubular Elastomer

.1 Insulation: to CAN/ULC-S102

.2 Insulation to have integral vapor barrier.

.3 Jacket: to CGSB 51-GP-52Ma.

.4 Maximum "k" factor: As noted in Insulation Schedule

.5 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.8 TIAC Code A-2: Rigid Molded Calcium Silicate

.1 Insulation: to ASTM C533

.2 Do not use on aluminum piping or austenitic stainless steel piping unless insulation has been tested in accordance with ASTM C795.

.3 Maximum "k" factor: As noted in Insulation Schedule

.4 Insulation to be in section and blocks, and with shapes to suit project requirements. Design to permit periodic removal and re-installation.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Air drying or Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 JACKET MATERIALS

.1 Polyvinyl Chloride (PVC):

.1 One-piece molded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colors: To match adjacent finish paint. Confirm with Owner's Representative

.3 Service temperatures: -20°C to 65°C (-4°F to 149°F)

.4 Moisture vapour transmission: 0.02 perm

.5 Thickness: 0.56mm (0.022")

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks

.3 Pressure sensitive vinyl tape of matching color.

.7 Special requirements:

.1 Indoor: Flame spread rating 25; Smoke development rating 50.

.2 Outdoor: UV rated material at least 0.5mm (0.02") thick.

.2 ABS Plastic:

.1 One-piece moulded type [and sheet] with pre-formed shapes as required.

.2 Colors: To match adjacent finish paint. Confirm with Owner's Representative

.3 Service temperatures: -40°C to 82°C (-40°F to 180°F)

.4 Moisture vapor transmission: 0.012 perm.

.5 Thickness: 0.75mm (0.03")

.6 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks

.3 Pressure sensitive vinyl tape of matching color.

.7 Locations:

.1 For outdoor use ONLY.

.3 Canvas:

.1 ULC listed 220 gm/m^2 (6.4 oz/yd^2) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: Compatible with insulation.

2.6 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, minimum 50mm (2”) wide.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5mm (0.06”) diameter stainless steel.

.5 Bands: Stainless steel, 19mm (¾”) wide, 0.5mm (0.02”) thick.

2.7 VAPOR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.8 INDOOR VAPOR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

Part 3 Execution

3.1 JOB CONDITIONS

.1 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement, poor workmanship, or material defects.

3.2 PRE-INSTALLATION

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions, where possible.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards and manufacturer’s recommendations.

.2 Ensure insulation is continuous through floor and wall sleeves etc. Pack around piping and ducts with fireproof self-supporting insulation materials, properly sealed.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75mm (3”).

.4 Finish insulation neatly at hangers, supports and other protrusions. Tightly fit insulation sections to pipe to make smooth and even surfaces. Cut insulation for proper fit where weld beads protrude. Bevel away from studs and nuts to allow their removal without damage to insulation. Trim closely and neatly around extending parts of pipe saddles, supports, hangers, clamp guides and seal with insulating/finishing cement.

.5 Install insulation at ambient temperatures within acceptable temperature ratings for tapes, sealants and adhesives.

.6 Apply insulation to provide smooth and even finish, uniform diameter, no sagging, wrinkling, etc.

.7 Maintain uninterrupted continuity and integrity of vapor retarder jacket and finishes.

.1 Install hangers, supports outside vapor retarder jacket.

.8 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, flanges and unions at equipment, primary flow measuring elements.

.2 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: Aluminum, high temperature fabric, PVC or ABS.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturer’s instructions. Ensure tight joints.

.2 Provide vapor retarder as recommended by manufacturer.

3.6 FINISHES

.1 Installation: To appropriate TIAC code CRF/1 through CPF/5.

3.7 INSULATION SCHEDULE – PIPING

System	Thermal Conductivity of Insulation		Pipe Sizes mm (in)	Insulation Thickness mm (in)	Recovery Jacket
	Conductivity Range W/m·°C (BTU·in/hr·ft²·°F)	Mean Rating Temp °C (°F)			
Domestic Cold Water	0.035 (0.24)	24 (75)	≤ 40 (1½)	15 (½)	Canvas
			≥ 50 (2)	25 (1)	

System	**Thermal Conductivity of Insulation**		**Pipe Sizes mm (in)**	**Insulation Thickness mm (in)**	**Recovery Jacket**
	Conductivity Range W/m·°C (BTU·in/hr·ft²·°F)	**Mean Rating Temp °C (°F)**			
Vents – Within 3m (10’-0”) of Roof Outlet	0.035 (0.24)	24 (75)	All Size	25 (1)	Canvas
Hot Water / Glycol (2) 61°C to 93°C (141°F to 200°F)	0.036-0.042 (0.25 to 0.29)	52 (125)	Runouts (1) ≤ 50 (2)	25 (1)	Canvas or Aluminum (4)
			≤ 25 to 50 (≤ 1 to 2)	25 (1)	
			≥ 65 (2½)	40 (1½)	
			≥ 65 (2½)	50 (2)	
			65 to 100 (2½ to 4)	75 (3)	
			≥ 125 (5)	90 (3½)	
Steam / Steam Condensate / Humidifier 94°C to 121°C (201°F to 250°F)	0.039-0.043 (0.27 to 0.30)	65 (150)	Runouts (1) ≤ 50 (2)	25 (1)	Canvas or Aluminum (4)
			≤ 25 to 50 (≤ 1 to 2)	40 (1½)	
			≥ 65 (2½)	50 (2)	
Chilled Water / Glycol 5°C to 13°C (41°F to 55°F)	0.033-0.039 (0.23 to 0.27)	24 (75)	Runouts (1) ≤ 50 (2)	1 (25)	Canvas or Aluminum (4)
			≤ 25 (≤ 1)	1 (25)	
			≥ 30 (≥ 1¼)	1 (25)	

Notes:

1) Refer to runouts to individual terminal units not exceeding 3.7m (12 ft) in length.
2) Do not insulate within radiation enclosures except for mains

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Provide for cleaning and degreasing of hot water heating, glycol, chilled water, air washer and cooling tower systems.

.2 Provide all necessary equipment and chemicals to treat hot water heating, glycol, chilled water, air washer and cooling tower systems.

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.3	Hydronic Systems: Steel	Section 23 21 13.02

1.3 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)

  .1 ASTM E202 — Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

  .1 Material Safety Data Sheets (MSDS).

1.4 QUALITY ASSURANCE

.1 Provide chemical treatment, chemicals and equipment by an agency that specializes in this type of work. This work shall be directed by the water treatment agency who, upon completion, shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

.2 Perform the cleaning and degreasing operation on site in conjunction with the mechanical contractor and submit written reports on all situations found, actions taken and final results. Reports shall be signed by the contractor, chemical treatment agency, and commissioning agency. Inform the engineer and commissioning agency 15 working days prior to commencing of work.

.3 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, mechanical contractor and commissioning agency.

.4 Chemical treatment agency shall provide directive and assistance to the mechanical contractor in the degreasing, cleaning and chemical treatment of all piping systems. Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilized for the duration of the cleaning process. Permanent equipment shall be flushed, degreased and chemically treated independent of the piping systems.

.5 Include for the costs of an independent testing agency, selected by the Owner, to take samples of all chemically treated hydronic systems, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should chemical treatment levels not meet the requirements of the specifications, the Contractor shall adjust treatment levels accordingly and cover the costs of the independent testing agency to take additional samples and tests.

.6 All equipment, service and chemical shall be from one supplier.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.

.3 Shop Drawings:

.1 Water treatment shop drawings are to include, at a minimum, the following:

.1 Proposed chemicals, including MSDS, and quantities

.2 Equipment (including pot feeders and side stream filter)

.3 Test kits

.4 Cleaning procedures

.5 Analysis report sample sheets.

.4 Report Submittals:

.1 Provide written reports containing procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.

.2 Submit written reports to the mechanical contractor and engineer containing results of tests taken seven days after completion of chemical treatment.

.3 Provide monthly site visits (12 minimum) within the warranty year to check the treatment, take samples, analyze and recommend proper addition of treatment. Provide written reports to the owner after each visit with a copy to the engineer.

1.6 CLOSEOUT SUBMITTALS

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

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 ACCEPTABLE AGENCY

.1 Chemical treatment agency shall provide equipment, chemicals and site supervision so as to fully comply with all requirements and their intent contained within this specification section.

.2 The water treatment specialist shall instruct the maintenance personnel before substantial completion. Written instructions of the treatment, dosages, control charts and test procedures shall be included in the maintenance manuals.

Part 2 Products

2.1 MATERIALS

.1 Provide sufficient chemicals to treat and test the systems from the time of activation and acceptance of the building for the first year of operation by the owner.

.2 Materials which may contact finished areas shall be colorless and non-staining. Chemicals used must comply with environmental and health standards applicable to the usage on this project.

.3 Provide necessary MSDS, test kits and log books for testing inhibitor levels.

2.2 EQUIPMENT

.1 Closed System (Heating, Chilled and Glycol Systems)

.1 Bypass Pot Feeder:

.1 All closed systems shall have a by-pass chemical pot feeder with an 8 litre (2.1 gal) capacity. It shall be constructed of heavy duty cast iron or welded steel, with funnel and complete with 20mm (¾”) NPT connections. Isolating valves shall be installed on the inlet, outlet, drain and funnel.

.2 Side Stream Filter:

.1 All closed systems shall have a side stream filter housing of stainless steel and brass construction using a 10 micron filter cartridge, with a minimum flow rate of 35 litres/minute (9.2 gpm). Mild steel filter housings are not acceptable. A Filter-Mate, flow indicator shall be installed in conjunction with the side stream filter. Connections shall be 20mm (¾”) NPT and all isolating valves shall be installed as per manufacturer’s instructions. Include 6 filter cartridges per system.

.3 All systems over 1000 litres (264 gal) volume require the installation of a corrosion coupon rack and one copper and one mild steel coupon for each rack. The coupon rack must include a one inch Filter-Mate flow indicator to prove adequate flow passing the coupons.

2.3 TEST KITS

.1 Test methods shall be titration type utilizing automatic burettes capable of determining 0.1 ppm, where this type of method may be used.

.2 All test kits shall be provided with adequate chemicals and reagents for one year of testing.

.3 Provide test kits as required to determine proper system treatment consisting of but not limited to the following:

- .1 Closed water test kit to determine proper inhibitor level.
- .2 Closed water test kit to determine proper conductivity level.
- .3 Closed water test kit to determine proper pH level.
- .4 Glycol systems treatment test kits to determine proper freeze point, this shall include a refractometer type tester.

.4 Provide test kits for hardness and chlorides in addition to those listed above.

.5 Provide a PH meter complete with three different calibration standard solutions.

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 GENERAL

.1 Timing: Systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.3 Conditions at time of cleaning of systems:

- .1 Systems: free from construction debris, dirt and other foreign material.
- .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
- .3 Strainers: clean prior to initial fill.
- .4 Install temporary filters on pumps not equipped with permanent filters.
- .5 Install pressure gauges on strainers to detect plugging.

3.3 SYSTEM CLEANING – CLOSED SYSTEMS

.1 Ensure reasonable care is exercised to prevent debris, dirt and other foreign material from entering the pipe during construction. This is to include proper protection of piping on site prior to installation, temporary caps on partial systems, and complete evacuation of moisture within systems being hydrostatically pressure tested.

.2 Chemical treatment agency shall, in conjunction with the mechanical contractor, review connections for complete draining and venting of the systems. The mechanical contractor shall provide adequate drain connections to completely drain the systems within one hour. Utilize water meter to record capacity within each system.

.3 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position. Isolate and bypass the following equipment during flushing and chemical treating: Cooling towers, plate and frame heat exchangers.

.4 Make systems completely operational, totally filled, thoroughly vented, and completely started.

.5 Add system cleaner and degreasant to flow systems at concentration of 1 kg (2.2 lbs) per 1000 L (265 gal) of water contained in systems for hot systems, 1 kg (2.2 lbs) per 500 L (135 gal) of water for cold systems.

.6 For hot water heating systems apply heat while circulating, raise temperature to 71°C (160°F) slowly and maintain at 71°C (160°F) for a minimum of 12 hours. Remove heat and circulate systems to 38°C (100°F) or less. Drain system, entirely at one time, including all low points and coils. Intermittent start/stop of drainage is not approved. The mechanical contractor to provide additional temporary pipe, pumps as necessary and drainage location for complete drainage. Refill the entire system with clean water, circulate for six hours at design temperature, provide complete venting and deaeration, repeat the draining procedure. Refill complete system with clean water and retest.

.7 For chilled water systems utilize the same procedures specified above for hot water heating systems; however, circulate at ambient temperature for a minimum of 48 hours.

.8 For glycol systems utilize the same procedure for hot water heating systems specified above.

.9 Inspect, clean of sludge and flush all low points with clean water after cleaning and degreasing process is completed. Include disassembly of components as required. All cleaning and flushing of low points, coils, boilers, etc., shall be done prior to final fill and chemical treatment.

3.4 HEATING WATER, CHILLED WATER AND GLYCOL SYSTEMS

.1 Provide and install one pot feeder for each individual system. Install complete with isolating and drain valves and necessary piping. Install as indicated on schematics.

.2 Treat closed systems with closed systems treatment introduced through pot feeder when required or indicated by test.

.3 Provide and install one side stream micron filter (between pump suction and discharge) per system, complete with isolation valves, drain valve, union, site glass, and flow regulating valve to limit flow thru filter to manufacturers recommendations.

.4 Supply 30, 10 micron cartridges per closed system.

3.5 STEAM SYSTEM CLEANING

.1 Chemical treatment agency shall, in conjunction with the mechanical contractor, review connections for complete draining and venting of the systems. The mechanical contractor shall provide adequate drain connections to completely drain the systems within one hour. Utilize water meter to record capacity within each system.

.2 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position.

.3 Make systems completely operational, totally filled, thoroughly vented, and completely started.

.4 Add system cleaner and degreasant to flow systems at concentration of 1 kg (2.2 lbs) per 1000 L (265 gal) of water contained in systems for hot systems, and fill the boilers only with cleaner for steam systems.

.5 For steam systems apply heat and raise boiler temperature to 71°C (160°F) for a minimum of 12 hours. Cool and drain as quickly as possible. Refill with clean water, drain, refill and test and check for sludge. Apply heat to produce steam for piping system. Maintain for 8 hours minimum. Bypass traps and waste all condensate to drain.

.6 Inspect, clean of sludge and flush all low points with clean water after cleaning and degreasing process is completed. Include disassembly of components as required. All cleaning and flushing of low points, coils, boilers, etc., shall be done prior to final fill of the boiler.

3.6 CLEANING

.1 Proceed in accordance with Section 01 74 00 – Cleaning.

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

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Piping

.2 Valves and fittings

.3 Accessories

1.2 RELATED REQUIREMENTS

.1 Common Work Results for HVAC — Section 23 05 00

1.3 REFERENCE STANDARDS

.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 American Society for Testing and Materials International (ASTM)

.1	ASTM A47/A47M	Standard Specification for Ferritic Malleable Iron Castings.
.2	ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
.3	ASTM B75M	Standard Specification for Seamless Copper Tube [Metric].
.4	ASTM B837	Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.

.3 Canadian Standards Association (CSA International)

.1	CSA W47.1	Certification of Companies for Fusion Welding of Steel.

.4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)

.1	CAN/CSA B149.1-15	Natural Gas and Propane Installation Code

.2 CAN/CSA B149.1HB Natural Gas and Propane Installation Code Handbook.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.4 QUALITY ASSURANCE

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.4 Comply with CSA B149.1 for natural gas systems.

.5 Health and Safety:

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

.3 Shop Drawings:

.1 Valve shop drawings are to indicate, at a minimum, the following:

.1 Manufacturer and model
.2 Materials of construction
.3 Pressure rating
.4 CSA certification

.2 Pressure regulator shop drawings are to indicate, at a minimum, the following:

.1 Manufacturer and model
.2 Materials of construction
.3 Pressure rating and capacity

1.6 CLOSEOUT SUBMITTALS

.1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PIPE AND FITTINGS

Size	Material	Fittings	Joint
1. Above Grade (Accessible Joints):			
50 (2”) and under	ASTM A-53, Schedule 40, continuous ERW or seamless	ANSI B16.3 MI, 1034 kPa rated	Threaded
65 (2½”) and over	ASTM A-53, Schedule 40, continuous ERW or seamless	ASTM A-234 standard weight wrought welded	Welded
2. Above Grade (Inaccessible Joints):			
All sizes	ASTM A-53, Schedule 40 continuous ERW or seamless	ASTM A-234 standard weight wrought welded	Welded

2.2 UNIONS, FLANGES AND COUPLINGS

.1 Size 50mm (2”) and under: 1035kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping. Unions to ANSI B16.3.

.2 Sizes 65mm (2½”) and over: 1035 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1035 kPa (150 psi) bronze slip-on flanges for copper piping. 1.6mm (0.06”) thick preformed synthetic rubber, compressed ARAMID/NBR (Durlon 8500). Gaskets to be rated for temperature and pressure of system. Flanges to ASTM A181, Grade 1. For 517 kPaG and higher, use Class 300. For all others, use Class 150.

2.3 VALVES

.1 Ball Valves:

.1 25mm (1”) and Smaller:

.1 Two piece brass body, full port chrome plated brass ball, brass trim, PTFE seats and packing

.2 Maximum Working Pressure: 2758 kPa (400 psi) cold working pressure.

.3 CSA certified.

.2 Plug Valves:

.1 Working Pressure: 1378 kPa (200 psi) cold working pressure

.2 Lubricated plug valve with Class 125 flanged ends or threaded ends, cast iron body, plugs and bonnet, standard port,

.3 Valves shall be furnished with a lubricating/sealing system to provide a means for delivering lubricant/sealant to the body-plug interface.

.4 CSA approved: 862 kPa (125 psi) max. pressure.

2.4 PRESSURE REGULATORS

.1 Provide direct operated gas pressure regulator where indicated on drawings and in specifications.

.2 Regulators shall have a cast iron or WCC steel body, threaded or flanged ends, and be sized to reduce gas pressure as indicated on drawings.

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 GENERAL

.1 Install piping approximately as shown, with all lines being carried parallel to building walls, close to the structure as possible, or as detailed on the drawings.

.2 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

.3 Install piping to allow for expansion and contraction without unduly stressing pipe or connected equipment.

.4 Provide clearance for proper access to valves, vents and unions.

.5 Use the following for branch connections off of main:

.1 Mains 100mm to 200mm (4” to 8”) inclusive: branches under 40mm (1½), use factory manufactured welding fittings to accommodate the take-off either welded or threaded; branches 50mm to 75mm (2” to 3”), use welding saddles; branches 100mm and over, use standard tee. Do not use welding saddles for branches greater than size of main.

.2 Mains 75mm (3"): branches under 25mm (1"), use factory manufactured welding fittings to accommodate the take-off welded or threaded; branches over 25mm, use standard tees.

.3 Mains 65mm (2½") and under: use standard tees for all branch take-offs.

.6 Do not use direct welded or screwed connections to valves, equipment or other apparatus. Make all connections with an accessible mechanical connection of a style consistent with the connecting pipe joints.

.7 Sleeve all pipe passing through partitions, walls and floors.

.8 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.

.9 Ensure no contact between copper and ferrous metal.

.10 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.11 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

.12 Provide for isolation of systems by section.

1.2 SCREWED CONNECTIONS

.13 American National Taper pipe thread must be used for all screwed connections. Remove burrs and chips and ream or file the pipe ends out to size or bore. Not more than two (2) imperfect threads exposed when joint make-up.

.14 Make screw joints metal to metal. Do not use lampwick or other packing material in making up screwed joints.

.15 Use Teflon tape, red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

1.3 WELDED CONNECTIONS

.16 Prepare mating surfaces properly, at least one mating surface shall be beveled. Longitudinally align piping carefully, set 3.2mm (⅛") space between mating surfaces and tack, using 6010 rod. Preheat the materials to be joined to at least 21°C (70°F). Make a minimum of three (3) passes; use 6010 rod for root pass, use 7018 rod for subsequent filler passes and final cover pass. Remove slag and flux after each pass by brushing or grinding. Remove voids from each pass by cutting or grinding and make good by back welding.

.17 Ensure complete penetration by the root pass. Measured at the inner diameter of the piping, the weld shall be a minimum of 1mm thicker than the pipe thickness.

.18 Do not caulk or pean welds.

1.4 GAS DISTRIBUTION LINES INSTALLATION

.19 Install the gas distribution lines in accordance with the policy and specifications of the Gas Utility, CAN/CSA B149.1, and the authority having jurisdiction.

.20 Weld all natural gas piping in concealed inaccessible spaces regardless of size.

.21 Install drip points:

- .1 At low points in piping system.
- .2 At connections to equipment.

.22 Paint all natural gas piping throughout with high visibility yellow paint, except where concealed where stripes are permitted. Refer to Section 23 05 53 – Identification for HVAC Piping and Equipment.

1.5 ROUTE AND GRADES

.23 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

3.3 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

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

3.4 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.

1.6 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Hot water heating system piping

.2 Glycol system piping

.3 Chilled and condenser water piping

.4 Testing

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Pipe Welding	Section 23 05 17
.3	HVAC Piping Insulation	Section 23 07 19
.4	Cleaning and Start-Up of HVAC Piping Systems	Section 23 08 16
.5	Hydronic Piping Specialties	Section 23 21 16

1.3 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)

.1	ANSI/AWS A5.8/A5.8M	AMD1 Specification Filler Metals for Brazing and Braze Welding.

.2 American Society of Mechanical Engineers (ASME)

.1	ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings.
.2	ASME B16.3	Malleable Iron Threaded Fittings.
.3	ANSI/ASME B16.4	Gray-Iron Threaded Fittings Classes 125 and 250.
.4	ASME B16.5	Pipe Flanges and Flanged Fittings.
.5	ASME B16.9	Factory-Made Wrought Buttwelding Fittings.
.6	ANSI/ASME B16.15	Cast Copper Alloy Threaded Fittings Classes 125 and 250.
.7	ANSI B16.18	Cast Copper Alloy, Solder Joint Pressure Fittings.
.8	ANSI/ASME B16.22	Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

.3 ASTM International

.1	ASTM A47/A47M	Standard Specification for Ferritic Malleable Iron Castings

.2 ASTM A53/A53M — Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless

.3 ASTM A536 — Standard Specification for Ductile Iron Castings

.4 ASTM B32 — Standard Specification for Solder Metal.

.5 ASTM B61 — Standard Specification for Steam or Valve Bronze Castings.

.6 ASTM B62 — Standard Specification for Composition Bronze or Ounce Metal Castings.

.7 ASTM B88M — Standard Specification for Seamless Copper Water Tube [Metric].

.8 ASTM E202 — Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 American Water Works Association (AWWA)

.1 AWWA C111 — Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

.5 Canadian Standards Association (CSA International)

.1 CSA B242 — Groove and Shoulder Type Mechanical Pipe Couplings

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.7 Manufacturers Standardization Society (MSS)

.1 MSS-SP-67 — Butterfly Valves.

.2 MSS-SP-70 — Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71 — Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS-SP-80 — Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85 — Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.4 QUALITY ASSURANCE

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect unless noted otherwise.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.6 CLOSEOUT SUBMITTALS

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

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PIPE AND FITTINGS (MECHANICAL)

Service	Size	Material	Fittings	Joint
1. Hot water/glycol heating	50 (2”) and under	ASTM A-53, Schedule 40, steel, continuous ERW or seamless	ANSI B16.3 MI, 1034 kPa rated	Threaded
2. Hot water/ glycol heating	65 – 250 (2½” – 10”)	ASTM A-53, Schedule 40, steel, continuous, ERW or seamless	ASTM A-234 standard weight, wrought welded	Welded
3. Chilled water	50 (2”) and smaller	ASTM A-53, Schedule 40, steel, continuous ERW or seamless	ANSI B16.3 MI, 1035 kPa rated	Threaded

Service	Size	Material	Fittings	Joint
4. Chilled water	65 (2½") and larger	ASTM A-53, Schedule 40, steel, continuous ERW or seamless	ASTM A-234 standard	Welded

2.2 UNIONS, FLANGES, AND COUPLINGS

.1 Size 50mm (2") and under: 1035kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping. Unions to ANSI B16.3.

.2 Sizes 65mm (2½") and over: 1035 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1035 kPa (150 psi) bronze slip-on flanges for copper piping. 1.6mm (0.06") thick preformed synthetic rubber, compressed ARAMID/NBR (Durlon 8500). Gaskets to be rated for temperature and pressure of system. Flanges to ASTM A181, Grade 1. For 517 kPaG and higher, use Class 300. For all others, use Class 150.

.3 Flange bolting: For systems up to 120°C (250°F), use carbon steel stud bolts, semi-finished, and heavy hex nuts, ASTM A307-GrB. For systems up to 215°C (420°F), use alloy steel bolts ASTM A193-GrB7, and semi-finished heavy hex nuts ASTM A194-Gr2H.

2.3 SOLDER

.1 Generally, use 95-5 solder for pressure service.

2.4 MISCELLANEOUS

.1 Use factory fabricated butt weld fittings for welded steel pipes.

.2 Use long radius elbows for steel piping.

Part 3 Execution

3.1 PIPING GENERAL

.1 Install piping approximately as shown, with all lines being carried parallel to building walls, close to the structure as possible, or as detailed on the drawings.

.2 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

.3 Install piping to allow for expansion and contraction without unduly stressing pipe or connected equipment.

.4 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.5 Use the following for branch connections off of main:

.1 Mains 100mm to 200mm (4” to 8”) inclusive: branches under 40mm (1½), use factory manufactured welding fittings to accommodate the take-off either welded or threaded; branches 50mm to 75mm (2” to 3”), use welding saddles; branches 100mm and over, use standard tee. Do not use welding saddles for branches greater than size of main.

.2 Mains 75mm (3”): branches under 25mm (1”), use factory manufactured welding fittings to accommodate the take-off welded or threaded; branches over 25mm, use standard tees.

.3 Mains 65mm (2½”) and under: use standard tees for all branch take-offs.

.4 Mains 250mm (10”) and over: branches up to and including 2 nominal sizes less than main, welded stub-ins, tee or saddles. Branches nominal size smaller and above, use standard tees.

.6 Use only eccentric reducing fittings. Install all reducers in steam lines with the piping in line at the bottom.

.7 Do not use direct welded or screwed connections to valves, equipment or other apparatus. Make all connections with an accessible mechanical connection of a style consistent with the connecting pipe joints.

.8 Sleeve all pipe passing through partitions, walls and floors.

.9 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.

.10 Ensure no contact between copper and ferrous metal.

.11 Provide drain valves at main shut-off valves, low points of piping and apparatus, and at the bottom of all risers.

.12 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.13 Do not run piping carrying liquids or steam over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.14 Provide for isolation of systems by section.

.15 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

.16 Minimum pipe size on heating water, chilled water and glycol system piping is 20mm (¾”).

.17 Pipe <u>all</u> drain pans on fan coil units, indoor pre-manufactured units, coils, computer room air conditioning units, unitary air conditioners, and outdoor pre-manufactured air handling units (with service corridor) to closest suitable funnel floor drain.

.18 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.

.19 Use insulating plastic spacers for copper pipe installation in metal studs.

3.2 SCREWED CONNECTIONS

.1 American National Taper pipe thread must be used for all screwed connections. Remove burrs and chips and ream or file the pipe ends out to size or bore. Not more than two (2) imperfect threads exposed when joint make-up.

.2 Make screw joints metal to metal. Do not use lampwick or other packing material in making up screwed joints.

.3 Use Teflon tape, red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

3.3 WELDED CONNECTIONS

.1 Prepare mating surfaces properly, at least one mating surface shall be beveled. Longitudinally align piping carefully, set 3.2mm (⅛") space between mating surfaces and tack, using 6010 rod. Preheat the materials to be joined to at least 21°C (70°F). Make a minimum of three (3) passes; use 6010 rod for root pass, use 7018 rod for subsequent filler passes and final cover pass. Remove slag and flux after each pass by brushing or grinding. Remove voids from each pass by cutting or grinding and make good by back welding.

.2 Ensure complete penetration by the root pass. Measured at the inner diameter of the piping, the weld shall be a minimum of 1mm thicker than the pipe thickness.

.3 Do not caulk or pean welds.

3.4 STRAY CURRENTS

.1 All wet lines shall be tested for stray currents at total contract performance.

.2 Isolate and correct stray currents to minimize electrolytic action potential.

3.5 ROUTE AND GRADES

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Grade hydronic heating water, glycol and chilled water piping generally up in the direction of flow, 25mm per 1200mm of run for proper venting at high points.

.3 In all water systems, install, at each low point, and at all equipment connections inside the isolating valves, hose bib drains in accessible locations. Use 20mm (¾") valves unless specifically noted otherwise.

.4 Slope steam piping .42% in direction of flow and condensate return piping .63%. Provide drip trap assembly at low points and points where condensate may collect in front of control valves. Run condensate lines from traps to nearest condensate cooler tank.

.5 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25mm (1") dia or line size whichever is greater and 150mm (6") high minimum. Square tees may only be used to assist with complete venting and draining.

.6 Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water.

.7 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns, and overflows to the nearest building drain. Arrange overflow drains so that drips may be readily seen.

3.6 HEAT TRANSFER PIPING SYSTEM TESTS

.1 Refer to Section 23 05 00 – Common Work Results for HVAC for system testing and startup requirements.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Air vents – automatic and manual

.2 Glycol solution

.3 Relief valves and fittings

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Valves – Bronze	Section 23 05 23.01
.3	Valves – Cast Iron	Section 23 05 23.02
.4	Valves – Cast Steel	Section 23 05 23.03
.5	Valves – Lubricated Plug	Section 23 05 23.04
.6	Butterfly Valves	Section 23 05 23.05
.7	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.8	Hydronic Systems: Steel	Section 23 21 13.02

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

  .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII

.2 ASTM International

.1	ASTM A47/A47M	Specification for Ferritic Malleable Iron Castings.
.2	ASTM A278M	Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (345 degrees C).
.3	ASTM A516/A516M	Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
.4	ASTM A536	Specification for Ductile Iron Castings.
.5	ASTM B62	Specification for Composition Bronze or Ounce Metal Castings.

.3 Canadian Standards Association (CSA International)

.1	CSA B51	Boiler, Pressure Vessel, and Pressure Piping Code.

1.4 QUALITY ASSURANCE

.1 All equipment shall be CSA or ULC listed.

.2 Thoroughly check system and make necessary corrections if system continually loses solution.

.3 Obtain inspection certificates for pressure vessels from Provincial Authorities.

.4 Perform tests determining strength of glycol solution before system is turned over to the Owner. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

- .1 Submit shop drawings for equipment noted in this section
- .2 Air vent shop drawings are to indicate, at a minimum, the following:
  - .1 Manufacturer and model
  - .2 Materials of construction
  - .3 Maximum working pressure and operating temperature
- .3 Glycol solution shop drawings are to indicate, at a minimum, the following:
  - .1 Manufacturer and product name
  - .2 Recommended use temperature range
  - .3 Fluid properties
  - .4 MSDS
- .4 Relief valve shop drawings are to indicate, at a minimum, the following:
  - .1 Manufacturer and model
  - .2 Materials of construction
  - .3 Maximum working pressure and operating temperature
  - .4 ASME certification

.5 Strainer shop drawings are to indicate, at a minimum, the following:

.1 Manufacturer and model

.2 Materials of construction

.3 Maximum working pressure and operating temperature

1.6 CLOSEOUT SUBMITTALS

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

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 AIR VENTS – AUTOMATIC

.1 Automatic air vents shall have brass body and cover and silicone rubber seal.

.2 Float shall be constructed of high temperature resistant polyethylene and shall be suitable for use with water or glycol systems.

.3 Maximum working pressure: 1034 kPa (150 psi)

.4 Temperature range: 5°C to 116°C (33°F to 240°F)

2.2 AIR VENTS – MANUAL

.1 Manual air vents shall have a brass body with metal seal and adjustable outlet.

.2 Maximum working pressure: 1034 kPa (150 psi)

.3 Maximum working temperature: 100°C (212°F)

2.3 GLYCOL SOLUTION

.1 Provide propylene glycol/water solution (phosphate based) suitable for a temperature range of -36°C (-33°F) to 104°C (220°F). Solution to be suitable for heating or cooling complete with appropriate corrosion inhibitors. Solutions must be factory premixed.

.2 Glycol solution to match base building glycol solution manufacturer and product.

.3 Pre-mixed percentage to match base building.

2.4 SAFETY RELIEF VALVES

.1 Provide a diaphragm operated safety relief valve with a brass or cast iron body. The valve seat and all moving parts exposed to the fluid are to be of non-ferrous material.

.2 Diaphragm and seat to be EPDM rubber; internal wetted parts to be brass.

.3 Safety relief valve to be ASME rated and labeled.

.4 Relief pressure to be as noted on drawings or as noted in equipment documentation.

2.5 STRAINERS

.1 Size 50mm (2”) and under: Screwed or threaded bronze body strainer, wye pattern, solid retainer cap with gasket. Strainer shall be rated to 2758 kPa (400 psi) WOG at 99ºC (210ºF); 862 kPa (125 psi) WSP at 178ºF (353ºF).

.2 Size 65mm (2½”) and larger: Cast iron body with Class 125 flanged connections, wye-pattern, cast iron blow-down plug, stainless steel screen, bolted and tapped iron retainer cap with graphite gasket and iron blow-down plug. Maximum Pressure (non-shock): 1379kPa (200 psi) at (99°C) 210°F WOG, 862 kPa (125 psi) at 178°C (353°F) WSP.

.3 Screen free area shall be minimum three times area of inlet pipe.

Part 3 Execution

3.1 GENERAL

.1 Install as per manufacturer’s recommendations.

.2 Maintain proper clearance to permit service and maintenance.

3.2 AIR VENTS

.1 Provide manual type at system high points and convection type heating units. Pipe air vent to serviceable location.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

.3 Pipe automatic air vents to drain.

3.3 RELIEF VALVES

.1 System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.2 Where one line vents several relief valves, cross sectional area shall exceed sum of individual vent areas.

.3 Pipe relief valve to nearest indirect floor drain.

.4 Provide safety relief valves on the following equipment:

.1 Pressure tanks

.2 Low pressure side of reducing valves

.3 Heating convectors

.4 Expansion tanks

.5 And where indicated on drawings

3.4 GLYCOL FILL

.1 Use food grade propylene glycol.

.2 Thoroughly clean and flush new piping system before glycol solution is added. Refer to section 23 08 16 – Cleaning and Start-Up of Mechanical Piping Systems.

.3 Manually pump glycol to charging tank from premixed barrel. Pressurize charging tank with compressed air to feed system through make-up line with pressure regulator.

.4 Provide one (1) extra 170 L (45 gal) drum of glycol, at turnover of the building to owner.

.5 Provide antifreeze solution lost from the systems from any cause other than neglect by the Owner during the first year of operation.

.6 Contractor shall record quantity of glycol/water mix in each glycol system. Data to be recorded in Operating and Maintenance Manuals.

3.5 STRAINERS

.1 Use temporary strainers during construction and system cleaning. Remove temporary and install permanent strainers prior to system balancing. Refer to Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

.2 Mount all strainers that are installed on horizontal piping on steam systems, with the centerline of the basket/screen at the same elevation as the centerline of the attached pipe.

.3 Provide strainers as indicated on the drawings and the following schedule:

.1 Steam piping (where indicated)

.2 Heating glycol pumps

.3 Chilled water pumps

.4 And where indicated on drawings.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Leave work area clean at the end of each day.

.3 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 All hydronic pumps except where integral with a manufactured piece of equipment

.2 Pumps controls where self-contained

.3 Accessories

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Common Motor Requirements for HVAC Equipment	Section 23 05 13
.3	Vibration and Seismic Controls for HVAC Piping and Equipment	Section 23 05 48
.4	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.5	Hydronic Specialties	Section 23 21 16

1.3 REFERENCE STANDARDS

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

  .1 ANSI/ASHRAE/IES Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers Association of Canada (EEMAC)

.3 National Electrical Manufacturers' Association (NEMA)

  .1 NEMA MG 1 Motors and Generators.

1.4 QUALITY ASSURANCE

.1 Ensure pumps operate at specified system fluid operating temperatures and pressures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve. Motor capacity shall be adequately sized to prevent overloading throughout entire range of performance curve.

.2 Comply with Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

1.5 ACTION AND INFORMATION SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

  .1 Submit manufacturer's instructions, printed product literature and data sheets for pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

.3 Shop Drawings:

.1 Submit shop drawings that include, at a minimum, the following:

.1 Pump performance and efficiency curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

.2 Pump construction including seals.

.3 Dimensions and recommended installation.

.4 Wiring and schematic diagrams.

.5 Accessories.

1.6 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: Submit operation and maintenance data for hydronic pumps for incorporation into manual.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1750 rpm unless specified otherwise.

.4 Pump connections shall be flanged. All pump flanges to be complete with pressure gauge tappings.

.5 Supply pumps compatible with system fluid and correct temperature range.

2.2 MOTORS – GENERAL

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 Motor Accessories and Hardware: matched sets of V-belt drives, adjustable, motor bases, and belt guards as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment, and as indicated.

.3 Motors for use with VFDs are to be inverter duty.

.4 Motors used with VFDs are to be completed with electrical bearing damage protection.

.1 Shaft Grounding

.1 All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground.

.2 Application Note: Motors up to 74.5 kW (100 hp) shall be provided with one shaft grounding ring installed either on the drive end or non-drive end. Motors over 74.5 kW (100 hp) shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

Standard of Acceptance: AEGIS Shaft Grounding Ring or equal

.2 High Frequency Bonding

.1 All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection.

.2 Provide proper grounding of motor frame for all inverter-driven induction motors

Standard of Acceptance: AEGIS High Frequency Grounding Strap or equal

2.3 INTEGRAL PUMP VFD

.1 Variable frequency drive (VFD) shall be factory mounted, wired, with a main disconnect switch and menu-driven graphical interface.

.2 The VFD shall provide near unity displacement power factor (cos Ø) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.

.3 The VFD shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.

.4 The VFD shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements.

.5 The VFD shall support direct communication with the building management system (BMS) with built-in support for the following protocols: BACnet™ MS/TP.

.6 The VFD shall be provided in an Enclosure rated to UL Type 12 suitable for indoor operation.

.7 The VFD shall support Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.

.8 The VFD shall provide a temperature controlled fan for cooling of the heat sink in the back panel.

.9 The VFD shall provide 2 Analog inputs (current or voltage) and 1 current output.

.10 The VFD shall provide 6 programmable Digital inputs with 2 configurable as outputs.

.11 The VFD shall support 2 programmable pulse inputs

.12 The VFD shall provide 2 programmable relay outputs

.13 The VFD shall provide 1 RS485 communication port

.14 The VFD system software shall be capable of sensorless control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.

.15 The VFD sensorless control shall operate under Quadratic Pressure Control (QPC) to ensure head reduction with reducing flow conforms to quadratic control curve.

.16 The VFD shall support a minimum head of 40% of design duty head.

.17 The VFD shall provide user adjustable control mode settings and minimum/maximum head set points using built-in programming interface.

.18 The VFD integrated control software shall be capable of controlling pump performance for non-overloading power at every point of operation.

.19 The VFD integrated control software shall be capable of maintaining flow rate data.

2.4 IN-LINE CIRCULATORS

.1 Type: Centrifugal, single stage, in-line, close-coupled.

.2 Casing: Cast iron, flanged suction and discharge, rated for 860 kPa (125 psi) or 1.5 times actual working pressure whichever is greater, gauge tappings at suction and discharge, vent and drain ports.

.3 Impeller: Bronze enclosed type or cadmium plated steel, with stainless steel cap screw to shaft.

.4 Shaft: Alloy steel with integral thrust collar and oil lubricated bronze sleeve bearings.

.5 Seal: Mechanical, rotary type, externally removable.

.6 Motor: Open drip proof construction, resilient mounted oil lubricated journal bearings.

2.5 VERTICAL CENTRIFUGAL PUMPS

.1 Type: Centrifugal, single stage, close coupled for motors less than 11.2 kW (15 HP), split coupled for motors 11.2 kW (15 HP) or larger, in-line, suitable for vertical operation.

.2 Casing: Cast iron, rated for 1200 kPa (175 psi), or 1.5 times actual working pressure whichever is greater, suction and discharge gauge ports, air vent, wear rings, seal flushing connection, drain plug.

.3 Impeller: Bronze, fully enclosed, keyed to shaft.

.4 Shaft: Stainless steel.

.5 Bearings: Ball bearings, regreaseable.

.6 Seals: Spring loaded carbon rotating against a stationary floating stellite seat and seat ring. Integral seal flush with micron filter on condenser water service.

.7 Motor: Open drip proof unless noted otherwise in pump schedule.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 INSTALLATION

.1 Install hydronic pumps to: CAN/CSA-B214 – Installation Code for Hydronic Heating Systems.

.2 In line circulators: install as indicated by flow arrows.

  .1 Support at inlet and outlet flanges or unions.

  .2 Install with bearing lubrication points accessible.

.3 Ensure that pump body does not support piping or equipment.

  .1 Provide stanchions or hangers for this purpose.

  .2 Refer to manufacturer's installation instructions for details.

.4 Pipe drain tapping to floor drain.

.5 Install volute venting pet cock in accessible location.

.6 Check rotation prior to start-up.

.7 Install pressure gauge test cocks.

.8 Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and plug cock balancing valve on discharge.

.9 Provide complete vibration isolation for assemblies including suction and discharge piping. Provide vibration isolated pipe hangers (resilient support) next to pumps on piping. Provide mounting supports on piping. Piping is not to be supported off pump flanges.

.10 At all in-line pump assemblies, provide flexible pipe connections at inlet and outlet to pumps. Substitution of flexible pipe connections with flexible pipe connector gasket/clamp assemblies (Victaulic or equal) will be considered. Install in accordance with manufacturer’s recommendations.

3.3 PERFORMANCE

.1 Refer to Pump Schedule on drawings.

3.4 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.

.2 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Common Work Results for HVAC — Section 23 05 00

.2 Steam Specialties — Section 23 22 14

.3 Heating Boilers — Section 23 52 00

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

.1	ASME B16.1-[05]	Cast Iron Pipe Flanges and Flanged Fittings: Class 25, 125, 250 and 800.
.2	ASME B16.25-[07]	Buttwelding Ends.
.3	ASME B16.3-[06]	Malleable Iron Threaded Fittings: Classes 150 and 300.
.4	ANSI/ASME B16.5-[03]	Pipe Flanges and Flanged Fittings: NPS ½ through 24.
.5	ANSI/ASME B16.9-[07]	Factory-Made Wrought Steel Buttwelding Fittings.
.6	ANSI B18.2.1-[96(R2005)]	Square and Hex Bolts and Screws (Inch Series).
.7	ANSI/ASME B18.2.2-[87(R2005)]	Square and Hex Nuts (Inch Series).

.2 American National Standards Institute (ANSI) / American Water Works Association (AWWA)

.1	ANSI/AWWA C111/A21.11-[07]	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.3 ASTM International Inc.

.1	ASTM A47/A47M-[99(2004)]	Standard Specification for Ferritic Malleable Iron Castings.
.2	ASTM A53/A53M-[07]	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
.3	ASTM A126-[04]	Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.

.4 Canadian Standards Association (CSA International)

.1 CSA W48-[06] Filler Metals and Allied Materials for Metal Arc Welding.

.5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

.1 MSS-SP-70-[2006] Cast Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS-SP-71-[2005] Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS-SP-80-[2003] Bronze Gate, Globe, Angle and Check Valves.

.4 MSS-SP-85-[2002] Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for valves and pipes and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit detailed shop drawings for valves clearly indicating, at a minimum, the following:

.1 Manufacturer and model

.2 Size and connection type

.3 Pressure rating

.4 Materials of construction

.5 Intended service

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

- .1 Steam to 103 kPa (15 psi)
  - .1 Up to NPS 150mm (6”): Schedule 40
  - .2 NPS 200mm (8”) and over: Schedule 40
- .2 Condensate: Schedule 40

2.2 PIPE JOINTS

.1 NPS 50mm (2”) and under: screwed fittings with lead-free dope or PTFE tape.

.2 NPS 65mm (2½”) and over: welding fittings and flanges to CSA W48.

.3 Flanges: plain or raised face. Flange gaskets to ANSI/AWWA C111/A21.11.

.4 Pipe thread: taper.

.5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1; ANSI/ASME B18.2.2.

.6 Buttwelding ends: to ANSI/ASME B16.25.

2.3 FITTINGS

.1 Pipe flanges: cast-iron to ASME B16.1, Class 125.

.2 Screwed fittings: malleable iron to ASME B16.3, Class 150.

.3 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.

.4 Buttwelding fittings: steel to ANSI/ASME B16.9.

.5 Unions: malleable iron, to ASTM A47/A47M or ASME B16.3.

2.4 VALVES FOR STEAM AND CONDENSATE SYSTEMS TO 103 KPA (15 PSI)

.1 Gate Valves

- .1 Up to 50mm (2”): Bronze body, inside screw, traveling stem, solid wedge, screw-in bonnet, threaded ends; rating 860 kPa (125 psi) steam.

.2 65mm (2½”) and Over: Cast iron body, flanged ends, O.S. and Y, rising stem, bronze trim, solid wedge, rating 860 kPa (125 psi) steam.

.2 Globe Valves

.1 Up to 50mm (2”): Bronze body, union bonnet, threaded ends, rating 1035 kPa (150 psi) steam.

.2 65mm (2½”) and Over: Cast iron body, bolted bonnet, flanged ends, O.S. and Y, renewable bronze seat ring, full guided bronze disc. Rating 860 kPa (125 psi) steam.

.3 Swing Check Valves:

.1 Up to 50mm (2”): Bronze body and disc, regrinding swing check, screw-in cap, threaded ends, rating 860 kPa (125 psi) steam.

.2 65mm (2½”) and Over: Cast iron body regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam.

.1 Valve Operators

.4 Provide suitable hand wheels for gate, globe or angle, radiation and drain valves.

.5 Provide valves larger than 100mm (4”) located more than 2.1m (7 ft) from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5m (5 ft) above floor and hook to clips to arrange to clear walking aisles.

2.5 VALVE OPERATORS

.1 Handwheel on valves except where specified.

.2 Handwheel with chain operators on valves installed more than 2400mm (8 ft) above floor in Mechanical Equipment rooms.

Part 3 Execution

3.1 APPLICATION

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

3.2 PREPARATION

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

3.3 ROUTES AND GRADING

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Slope steam piping 0.5% in direction of flow and condensate return piping 0.7%. Provide drip trap assembly at all low points and in front of control valves. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.

.3 Make reductions in steam pipes with eccentric reducing fittings installed to provide drainage and venting. Bottom flat for steam.

.4 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns, and overflows to the nearest building drain.

3.4 INSTALLATION

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 Connect branch lines into top of mains.

.4 Drip pocket: line size.

3.5 VALVES

.1 Install globe valves around gate valves 200mm (8”) and over.

3.6 TESTING

.1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Test pressure: 1-1/2 times maximum system operating pressure or 860 kPa whichever is greater.

3.7 SYSTEM START-UP

.1 In accordance with Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

1.	Common Work Results for HVAC	Section 23 05 00
2.	Steam and Condensate Heating Piping	Section 23 22 13
3.	Heating Boilers	Section 23 52 00
4.	Air Handling – Built-Up	Section 23 73 00.13

1.2 REFERENCE STANDARDS

.1 American Society for Mechanical Engineers (ASME International)

.2 ASTM International Inc.

.1	ASTM A126-[04]	Standard Specification for Grey Iron Castings for Valves, Flanges and Pipe Fittings.
.2	ASTM A167-[99(2004)]	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
.3	ASTM A216/A216M-[07]	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
.4	ASTM A240/A240M-[07e1]	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
.5	ASTM A276-[06]	Standard Specification for Stainless Steel Bars and Shapes.
.6	ASTM A278/A278M-[01(2006)]	Standard Specification for Grey Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).
.7	ASTM A351/A351M-[06]	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
.8	ASTM A564/A564M-[04]	Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
.9	ASTM B62-[02]	Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature Canadian Registration Number (CRN), and datasheets for steam traps, vacuum breakers, pressure reducing valves, air vents, safety relief valves, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Shop Drawings:

.1 Submit steam trap shop drawings that include, at a minimum, the following:

.1 Manufacturer and model

.2 Materials of construction

.3 Maximum operating pressure

.4 Connection type and size

.4 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.2 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 MATERIALS

.1 Cast steel: to ASTM A216/A216M.

.2 Cast iron: to ASTM A278, Class 300.

.3 Bronze: to ASTM B62.

.4 Stainless steel: to ASTM A351/A351M.

2.2 FLOAT AND THERMOSTATIC STEAM TRAPS 0-110 KPA (15 PSI)

.1 Application: as indicated.

.2 Materials: body - cast iron; valve - stainless steel thermostatic type with stainless steel seat; float and mechanisms - stainless steel; air vent – stainless steel.

.3 Capacity: as indicated.

2.3 INVERTED BUCKET STEAM TRAP 0-1000 KPA (145 PSI)

.1 Application: as indicated.

.2 Materials: body - cast iron; valve - chrome steel; bucket-stainless steel, with bimetal air vent.

.3 Capacity: as indicated.

2.4 SAFETY AND RELIEF VALVES

.1 Spring loaded type of cast iron with high capacity and semi-nozzle and to ASME code.

.2 Material: body - cast iron; valve - housing malleable iron; spring - steel, cadmium plated; bronze/brass trim.

.3 Capacity: as indicated

2.5 DRIP PAN ELBOWS

.1 Application: on discharge of steam safety relief valves [as indicated].

.2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.6 PIPELINE STRAINERS UP TO 50MM (2”)

.1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.

.2 Working pressure: 860 kPa (125 psi).

.3 Body: cast iron.

.4 Connections: screwed.

.5 Screen: stainless steel with 0.8mm perforations.

2.7 PIPELINE STRAINERS 65MM (2-1/2”) AND OVER

.1 Application: ahead of condensate pumps, steam traps, control valves [as indicated].

.2 Working pressure: 860 kPa.

.3 Body: cast iron.

.4 Connections: flanged.

.5 Blowdown connection 30mm (1¼”) complete with gate valve and cap.

.6 Screen: stainless steel with 3.2 mm perforations.

Part 3 Execution

3.1 APPLICATION

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

.2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

.1 Install as indicated.

.2 Ensure clearance for removal of basket.

.3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

.1 Pipe to atmosphere independent of other vents and in accordance with applicable code.

.2 Support discharge pipe against reaction forces and to take up thermal movement.

.3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

.1 Install unions on inlet and outlet.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Low, medium and high pressure ductwork

.2 Fasteners

.3 Sealing and sealants

.4 Testing

1.2 RELATED REQUIREMENTS

.1	Air Duct Cleaning for HVAC Systems	Section 23 01 31
.2	Common Work Results for HVAC	Section 23 05 00
.3	Hanger and Supports for HVAC Piping and Equipment	Section 23 05 29
.4	Vibration and Seismic Controls for HVAC	Section 23 05 48
.5	Identification for HVAC Piping and Equipment	Section 23 05 53
.6	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.7	Duct Insulation	Section 23 07 13
.8	Air Duct Accessories	Section 23 33 00
.9	Louvers, Intakes and Vents	Section 23 37 20

1.3 REFERENCE STANDARDS

.1 American Conference of Governmental Industrial Hygienists (ACGIH)

.1 A Manual of Recommended Practice for Industrial Ventilation

.2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.3 American Society for Testing and Materials (ASTM)

.1	ASTM A480/A480M	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
.2	ASTM A635/A635M	Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
.3	ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM C423 — Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.5 ASTM E90 — Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.6 ASTM E477 — Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

.4 National Fire Protection Association (NFPA)

.1 NFPA 90A — Standard for the Installation of Air-Conditioning and Ventilating Systems.

.5 National Research Council of Canada

.1 National Energy Code of Canada for Buildings 2017 (NECB).

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible

.2 SMACNA HVAC Air Duct Leakage Test Manual

.3 IAQ Guideline for Occupied Buildings Under Construction

1.4 QUALITY ASSURANCE

.1 Use highest quality materials conforming to the appropriate ASTM and ANSI specifications.

.2 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities having jurisdiction.

.3 Ductwork shall meet the requirements of NFPA No. 90A - Air Conditioning and Ventilating Systems.

.4 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks as a minimum where more stringent requirements are not identified in the contract documents. Straight tap fittings and dovetail joints are not permitted. Comply with SMACNA Duct Construction Standards for duct pressure rating including requirements for cross breaking, reinforcement, longitudinal seams, transverse joints and sealing. Confirm pressure ratings with consultant prior to fabrication.

.5 Ductwork used on this project shall be clean and free from scale, corrosion and deposits. All ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.

.6 All ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts, and sealants, and include product characteristics, performance criteria, physical size, finish and limitations.

1.6 DEFINITIONS

.1 Low Pressure: Static pressure in duct less than 500 Pa (2” WG) and velocities less than 10 m/s (2000 fpm).

.2 Medium Pressure: Static pressure in duct less than 1500 Pa (6” WG) and velocities greater than 10 m/s (2000 fpm).

.3 High Pressure: Static pressure over 1500 Pa (6” WG) and less than 2500 Pa (10” WG) and velocities greater than 10m/s (2000 fpm).

.4 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.7 DELIVERY & STORAGE

.2 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.3 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 PRODUCT OPTIONS

.1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent round and rectangular ducts. No variation of duct configuration or sizes permitted except by written permission of the consultant. Extent of options will be limited for example; round duct will not be permitted on ducts downstream of terminal units except where shown.

.2 Use of a pre-manufactured bolted transverse duct joint/seal connection is permitted on ductwork constructed of material between 1.2mm and 0.8mm inclusive.

2.2 MATERIALS

.1 Make round, oval and rectangular ductwork unless specifically noted otherwise of lock-form quality galvanized steel, ASTM designation A93-59T, with copper bearing base metal having 0.20% copper added and 380 g/m² class zinc coating to ASTM A525-M87.

Galvanizing quality must allow sheets to be bent flat upon themselves with no fracture to the coating or base metal.

.2 Fabricated metal air plenums:

.1 Casings: Galvanized steel lock forming quality, having galvanized coating of 380 g/m2 (0.078 lb/ft2) for both sides.

.2 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.3 Sealant: Water resistant, fire resistive, compatible with mating materials.

.3 Flexible Duct Liner: line with specified thickness of black matte faced insulation, Manson Akousti-Liner. N.R.C. for 25mm material: minimum of 0.75 absolute roughness not greater than 0.0008 feet, substrate must not be dark in colour. Seal edges and joints with an approved fire resistant mastic. Protect leading and trailing edges with sheet metal edging.

.4 Rigid Duct Liner: Manson Akousti-Liner-R, N.R.C. for 25mm material of 0.80. Rigid liner to be used in plenums and/or where maximum air velocities do not exceed 24.5 m/sec.

.5 Duct Liner Protection, High Velocity: perforated galvanized steel meeting ASTM A-527-67. Minimum thickness, ducts, 0.70mm thick to 1200mm duct diameter, 1.0mm over 1200mm fittings 1.0mm thick all sizes.

.6 Fasteners: Use rivets and bolts throughout, sheet metal screws accepted on low pressure ducts. Fasteners to be corrosion resistant. Kitchen exhaust ducts to be welded.

.7 Sealants: water based, fire resistive, compatible with mating materials, ULC labeled, MP multi-purpose high velocity sealant.

.8 Strap Hangers: galvanized steel as ductwork but one (1) gauge heavier.

.9 Hangers: Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.10 Traverse Supports and Reinforcing: galvanized steel as ductwork or mild steel sections.

2.3 DUCTWORK PRESSURES

.1 Provide ductwork and plenums fabricated from galvanized steel for the static pressure categories listed below.

.1 1000 Pa (4" W.G.) static pressure:

.1 All supply air ductwork downstream from supply air handling units discharge, to the upstream side of mixing boxes/air valves.

.2 All exhaust and return air ductwork downstream from return/exhaust air valves to the return/exhaust fans and downstream from the return/exhaust fans to the air handling units and/or outdoor relief.

.2 500 Pa (2" W.G.) static pressure

.1 All supply ductwork downstream from mixing boxes/air valves to terminal air outlets.

.2 All supply ductwork on systems without mixing boxes/air valves.

.3 All return air ductwork and plenums, except where otherwise specified.

.4 All exhaust and relief air ductwork and plenums, except where otherwise specified (welding/sawdust exhaust).

.5 All outdoor air ductwork, except as otherwise specified.

2.4 FABRICATION – DUCTWORK

.1 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450mm (18”) cross break for rigidity. Open corners are not acceptable.

.2 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.3 Construct tees, bends and elbows with radius of not less than 1½ times width of duct on centre line.

.4 Increase duct sizes gradually not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.

.5 Rigidly construct metal ducts with joints mechanically tight, substantially air-tight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.

.6 Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two (2) ducts maintaining original duct area.

2.5 LINED DUCTWORK

.1 Comply with SMACNA “Duct Liner Application Standard”.

.2 Unless otherwise indicated, maintain the net free area of the duct dimensions given on the drawings. Increase metal duct dimensions as necessary to compensate for the addition of the liner.

.3 Unless otherwise indicated, lining thickness is 25mm (1”).

.4 Where round ductwork is indicated to be acoustically insulated, it shall consist of two concentric round ducts with 25 mm (1") thick flexible fibrous glass duct liner between the two ducts. The inner duct shall be perforated and correspond to the duct diameter noted on the drawings. The outer duct shall be suitable for the static pressure and shall be sealed airtight where it joins the adjacent ductwork.

.5 Provide duct lining where indicated on drawings.

2.6 TURNING VANES

.1 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 0.76mm (22 ga). Vanes shall be spaced at 40mm (1-1/2") centers and shall turn through 90 deg., with a radius of 50mm (2"). Vanes shall not include a straight trailing edge. Refer to Figs. 2-3 and 2-4 of the SMACNA Duct Standards. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 0.86mm thick (18 ga).

.2 For 500 Pa (2" WC) pressure systems, install tie rods to limit the maximum unsupported vane length to 914mm (36"). Refer to Fig. 2-4 of the SMACNA Duct Standards.

.3 For 750 Pa (3" WC) and greater pressure systems, install tie rods to limit the maximum unsupported vane length to 460 mm (18"). Refer to 2-4 of the SMACNA Duct Standards.

.4 When turning vanes are located in acoustically insulated ductwork, provide turning vanes of perforated metal type with fiberglass inside.

2.7 DUCT SEALING

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, shall be sealed using,

  .1 Low Pressure Ductwork:

    .1 Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5mm (16 gauge) use heavy mastic type sealant.

    .2 Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.

    .3 Other Joints: Heavy mastic type sealant.

  .2 Medium and High Pressure Ductwork: Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Duct tape, used on its own, is not permitted as a sealing method.

.3 Surfaces to receive sealant are t o be free from oil, dust, dirt, moisture, rust and other substances that inhibit, or prevent, bonding.

.4 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the engineer.

.5 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

2.8 SEAL CLASSIFICATION

.1 All ducts to be sealed to SMACNA Sealing Class A.

.2 Seal classification:

.1 Class A: Longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: Longitudinal seams, transverse joints and connections made airtight with tape, sealant or a combination thereof.

.3 Class C: Transverse joints and connections made airtight with tape, sealant, gaskets or a combination thereof. Longitudinal seams unsealed.

2.9 SEALANT

.1 Sealant:

.1 Oil resistant, water borne, polymer type flame resistant duct sealant.

.2 Temperature range of -30°C to 93°C (-22°F to 200°F).

2.10 TAPE

.1 Tape: Polyvinyl treated, open weave fiberglass tape, 50mm (2”) wide.

2.11 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

.2 The maximum permitted leakage shall be calculated as follows:

$$L_{max} = (C_L \cdot (P)^{0.65}) / 720$$

Where:

L_{max} = Maximum permitted leakage, in L/s/100m^2 of duct surface area.

C_L = Leakage class from Section 2.1.1.

P = Maximum operating static pressure, Pa

.3 Leakage Classes Schedule

Shape of Duct	Maximum Operating Static Pressure, Pa		
	< 500	500-750	> 750
	C_L		
Rectangular	24	12	6
Round	12	6	3

2.12 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Fire stopping material and installation must not distort duct.

2.13 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

  .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

  .2 Maximum size duct supported by strap hanger: 500mm (20”).

  .3 Hanger configuration: to SMACNA.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.

  .1 Visually inspect substrate in presence of Departmental Representative.

  .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

  .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

.1 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.

.2 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.3 Prior to the fabrication of ductwork, co-ordinate and field measure all ductwork to ensure a complete installation respecting all other services. Fabricate ductwork from field measurements and not from plans and shop drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.4 Provide all necessary fittings, offsets, and alternate construction methods to facilitate the installation.

.5 Proper sized openings shall be arranged for in the correct locations through all slabs and walls. Openings shall be planned to include for the installation of fire dampers at all rated fire separations.

.6 Where a duct contains a fire or smoke damper, construct the duct so that the free area of the duct is maintained through the fire or smoke damper.

.7 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.

.8 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps. Clean any ductwork found to be dirty at no extra cost to the Contract.

3.3 INSTALLATION

.1 Make the taper of diverging transitions less than 20 deg. and the taper of converging transitions less than 30 deg., in accordance with Fig. 2-9 of the SMACNA Duct Standards. Maximum divergence upstream of equipment to be 30 deg. and 45 deg. convergence downstream.

.2 Make the inside radius of any rectangular duct elbow at least equal to the duct width, measured in the direction of the radius. If space conditions do not permit a full radius elbow to be installed, use square elbows with multi-blade turning vanes.

.3 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions and maximize acoustic performance of the ductwork.

.4 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with SMACNA Duct Standards. Adjustment shall be accessible outside the duct with lockable quadrant operator or through the grille or register with key-operated worm gear mechanism.

.5 Cross-break or bead all metal duct panels unless noted otherwise.

.6 Do not cross-break duct panels on the following types of ducts:

.1 On 750 Pa (3" WC) and greater static pressure systems.

.2 Bottom duct panels when ductwork is handling moisture.

.7 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450mm (18”) cross brace for rigidity. Open corners are not acceptable.

.8 Construct tees, bends and elbows with radius of not less than 1-1/2 times width of duct on centre line. Where not possible and where rectangular elbows are specified, provide turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fiberglass inside.

.9 Do not use flexible duct to change direction. Provide a minimum of three (3) duct diameters of straight metal duct between box inlet and flexible connector.

.10 Connect diffusers or grilles to low pressure ducts with 300mm (12”) maximum stretched length of flexible duct. Hold in place with caulking compound and strap or clamp.

.11 Support risers at their base and at each floor, but at not more than 3.7m (12 ft) intervals. Riser supports to be in accordance with SMACNA and ASHRAE.

.12 Ducts passing through non-rated fire separations, sound insulated walls and through non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent passage of smoke and/or transmission of sound. (U.L.C. approved fire stop sealant is not a requirement). Where ducts are insulated provide a 0.61mm (24 ga) thick galvanized steel band tightly fitted around insulation and then caulk to band.

.13 Install breakaway joints in ductwork on sides of fire separation.

.14 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.15 Manufacture duct in lengths and dimensions to accommodate installation of acoustic duct lining where indicated on drawings. Where a duct is to be internally insulated, enlarge the duct so as not to reduce the duct free area.

.16 Coordinate the location of duct access doors with other mechanical and electrical services, and ceiling and walls. Arrange access doors so that they open against the airflow and static pressure.

.17 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.18 Prove that ductwork is substantially air tight before covering or concealing.

.19 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 23 33 00 – Air Duct Accessories.

.20 Provide moisture collection sections inside all louvres for outside air and exhaust air.

3.4 WATERTIGHT DUCTS

.1 Provide watertight duct for:

 .1 Outside air intake.

 .2 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

 .1 Construct ductwork with three-sided bottom sections and a separate top panel.

 .2 Weld or solder joints on bottom and side sections.

 .3 Seal other joints with duct sealer.

.3 Grade all ductwork handling moisture, a minimum of 1:120 (1" in 10 ft) back to the source or at low points in the ductwork, provide a 150mm (6") deep drain sump and 30mm (1¼") diameter drain connection, with deep seal trap and trap primer, and piped to an indirect drain.

.4 Fit base of riser with 150mm (6") deep drain sump and 30mm (1¼") diameter drain connection, with deep seal trap and trap primer, and piped to an indirect drain.

3.5 HANGERS

.1 Install strap hangers and angle hangers in accordance with SMACNA. Angle hangers to be complete with locking nuts and washers.

.2 Attachments to the structure shall be compatible with the structure and selected for the load of the ductwork.

.3 Hanger spacing to be in accordance with SMACNA and ASHRAE.

.4 Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

3.6 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA and with manufacturer's recommendations.

.2 Bed tape in sealant and recoat with a minimum of one (1) coat of sealant to manufacturers recommendations.

3.7 LEAKAGE TESTS

.1 Refer to Section 23 05 94 – Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Do leakage tests in sections.

.4 Make trial leakage tests as instructed to demonstrate workmanship.

.5 Do not install additional ductwork until trial test has been passed.

.6 Complete test before performance insulation or concealment Work.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Leave work area clean at the end of each day.

.3 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Duct access doors

.2 Instrument test ports

.3 Turning vanes

1.2 RELATED REQUIREMENTS

.1	Air Duct Cleaning for HVAC Systems	Section 23 01 31
.2	Common Work Results for HVAC	Section 23 05 00
.3	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.4	Metal Ducts – Low Pressure to 500 Pa	Section 23 31 13.01
.5	Louvers, Intakes and Vents	Section 23 37 20

1.3 REFERENCE STANDARDS

.1 National Fire Protection Association (NFPA)

.1 NFPA 90A — Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible

.3 Underwriters Laboratories of Canada (ULC)

.1 UL-181 — Standard for Factory Made Air Ducts and Air Connectors

1.4 QUALITY ASSURANCE

.1 Access doors shall be ULC labelled.

.2 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

.3 Shop Drawings:

.1 Submit shop drawings for equipment noted below.

.1 Duct access doors shop drawings are to indicate, at a minimum, the following:

.1 Manufacturer and model

.2 Materials of construction

.3 Latch type

1.6 CLOSEOUT SUBMITTALS

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

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 DUCT ACCESS DOORS

.1 Square/Rectangular Doors: Frame shall be die-formed of 0.85mm (22 gauge) galvanized steel complete with notched knock-over tabs for installation. Door shall be die-formed 0.85mm (22 gauge) galvanized steel and be of double skin construction with 25mm (1”) of insulation fully enclosed within. A positive seal, polyethylene gasket shall be secured to each door for low leakage. Door shall meet SMACNA requirements for systems up to 500 Pa (2” wc) and be hinged on one side with camlock closure.

.2 Flat Oval Doors: Frame shall be of oval design, die-formed of minimum 0.70mm (24 gauge) galvanized steel with 5mm (3/16”) pre-punched mounting holes. Door shall be die-formed of minimum 0.70mm (24 gauge) galvanized steel and be of double skin construction with 25mm (1”) of insulation fully enclosed within. Door shall be complete with safety handle on sizes 200mm x 125mm 8”x5”) thru 460mm x 250mm (18”x10”), two safety handles on larger sizes. Door shall be secured with plated steel wing nut fasteners, with bulb type seal integrally fastened to door for positive seal.

2.2 INSTRUMENT TEST PORTS

.1 Cast zinc alloy construction with a heavy gauge zinc plated cap.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 25mm (1”) minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket. Provide flat gaskets for rectangular ductwork and molded gaskets for round ductwork

2.3 TURNING VANES

.1 Factory or shop fabricated full radius arc; single blade vanes to SMACNA recommendations.

.2 Acoustic vanes constructed in airfoil pattern with fibrous glass padding, 0.8mm perforated lining.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 INSTALLATION

.1 Install where indicated.

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

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

.7 Corrections and adjustments conducted by [Consultant] [Departmental Representative] [

3.3 DUCT ACCESS DOORS

.1 Provide access door minimum 450mm x 350mm or 50mm (18”x14” or 2”) smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:

- .1 At 6.0m (20’-0”) intervals on all horizontal ducts.
- .2 At 12.0m (40’-0”) intervals in all vertical duct systems.

.3 At the base of all duct risers.

.4 Both sides of turning vanes in all ducts.

.5 At each side of all heating or cooling coils.

.6 At all locations of internally duct mounted devices including automatic dampers, damper motors, duct mounted smoke detectors and heat detectors, and control sensors and devices.

.7 And where required by code.

3.4 INSTRUMENT TEST PORTS

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

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Cut holes with hole saw and deburr edges. Install test holes with rivets or bolts with head on the interior of the ductwork.

.5 Provide at suitable locations on each duct main at the suction and discharge of every fan to facilitate total and static pressure readings.

.6 Locations:

.1 For traverse readings:

.1 Ducted inlets to roof and wall exhausters.

.2 Inlets and outlets of other fan systems.

.3 Main and sub-main ducts.

.4 And where required to facilitate total and static pressure readings.

.2 For temperature readings:

.1 At outside air intakes.

.2 At inlet and outlet of coils.

.3 Downstream of junctions of two converging air streams of different temperatures.

.4 And where required to facilitate required temperature readings.

3.5 TURNING VANES

.1 Install turning vanes in duct elbows where centerline radius is less than 1¼ times the turning dimension of the duct.

.2 Install in accordance with SMACNA recommendations.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Centrifugal fans

1.2 RELATED REQUIREMENTS

Common Work Results for HVAC	Section 23 05 00
Common Motor Requirements for HVAC Equipment	Section 23 05 13
Variable Frequency Drives for HVAC Equipment	Section 23 05 14
Hangers and Supports for HVAC Piping and Equipment	Section 23 05 29
Vibration and Seismic Controls for HVAC	Section 23 05 48
Identification for HVAC Piping and Equipment	Section 23 05 53
Testing, Adjusting and Balancing for HVAC	Section 23 05 93
Metal Ducts – Low Pressure to 500 Pa	Section 23 31 13
Air Duct Accessories	Section 23 33 00

1.3 REFERENCE STANDARDS

.1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)

.1	ANSI/AMCA Standard 99	Standards Handbook.
.2	ANSI/AMCA Standard 210	Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
.3	ANSI/AMCA Standard 300	Reverberant Room Method for Sound Testing of Fans.
.4	ANSI/AMCA Standard 301	Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI) / American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)

.1	ANSI/ASHRAE 51	Laboratory Methods of Testing Fans for Rating

1.4 QUALITY ASSURANCE

.1 All fans of any specific type on the project shall be supplied by a single manufacturer.

.2 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal for performance <u>and</u> sound ratings.

.3 Fans shall bear CSA label.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings that include, at a minimum, the following information:

.1 Manufacturer and model

.2 Fan size and class for application,

.3 Fan performance including capacity, external static pressure and fan speed

.4 Fan curves showing fan performance with fan and system operating point plotted on curves

.5 Dimensions and weight

.6 Motor capacity and electrical characteristics

.7 Acoustical data

.8 Accessories

1.6 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data:

.1 Submit operation and maintenance data for HVAC fans for incorporation into manual.

1.7 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Provide:

.1 Matched sets of belts for each belt drive fan.

1.8 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 Fans to be statically and dynamically balanced so no objectionable vibration or noise is transmitted to occupied areas of the building. Fans to be constructed in conformity with ANSI/AMCA Standard 99.

.2 Sound ratings to comply with ANSI/AMCA Standard 301 and tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.

.3 Performance ratings to be based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

.4 Provide fixed sheaves for all motors, independently of size.

.5 Factory primed before assembly in colour standard to manufacturer.

.6 Fans are to be capable of accommodating static pressure and flow variations of ±10% of schedule values with no objectionable operating characteristics.

.7 Select and design wheel and shaft so that fan does not pass through any critical speed to reach maximum operating speed.

.8 Unless otherwise indicated, equip fans with heavy duty grease lubricated ball or roller bearings of self-aligning type, with ample thrust provision to prevent end play during normal bearing life. Ensure lubricating points are readily and safely accessible after installation. Provide extension lubrication tubes where bearings are not easily accessible.

.9 Supply replacement pulleys and sheaves for fans as required to properly balance the systems to design flows at actual job site static pressure conditions. Obtain requirements from balancing agency.

.10 Size motors for parallel operating fans for non-overloading operation with only one fan operating.

.11 Provide guard screens for fans having exposed inlet or outlets, bolted to permit removal. Provide belt guards with tachometer holes.

.12 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.

.13 Use ground and polished steel shafts with rust preventative coating.

.14 Finish all ferrous parts with primer and baked enamel topcoat.

2.2 MOTORS – GENERAL

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 Motor Accessories and Hardware: matched sets of V-belt drives, adjustable, motor bases, belt guards, coupling guards fan, outlet and/or inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment, and as indicated.

.3 Motors for use with VFDs are to be inverter duty rated and meet the current NEMA MG1 Part 31 requirement.

2.3 CENTRIFUGAL FANS

.1 Provide single width, single inlet centrifugal fan, V-belt or direct drive as indicated, with motor and weather proof protective enclosure for motor and drive. Protective hoods to have vents for motor cooling and be readily removable.

.2 Belt drive fans shall be in AMCA arrangement 10. Direct drive fans shall be in AMCA arrangement 4.

.3 Fan bases are to be constructed of heavy gauge galvanized steel and are to be equipped with lifting lugs.

.4 Fans to include Nema-3R disconnect switch, bolted access door, 25mm (1”) unthreaded drain hole, extended lube lines, and weather hood as base features.

.5 Fan housing and impeller to be powder coated with a thermosetting polyester urethane, electrostatically applied to provide uniform thickness and a clean appearance. No uncoated metal fan parts are acceptable.

.6 Fan Housing and Outlet

  .1 Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.

  .2 Fan shall be of airtight construction with the scroll panel material formed and embedded into the side panels. All interior and exterior surface steel shall be powder coated.

  .3 Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.

  .4 Belt driven fans shall have an OSHA compliant belt guard which completely covers the motor pulley and belt(s).

.7 Fan Wheel

  .1 The fan wheel shall be of the non-overloading single width airfoil, backward inclined or forward curved centrifugal type as indicated in Fan Schedule. Wheels to be constructed of aluminum or galvanized steel.

.2 Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.

.3 Fan wheel shall be manufactured of single thickness blades securely riveted or welded to a heavy gauge back plate and wheel cone.

.8 Fan Motor and Drive

.1 Belt Drive

.1 Motors shall be open drip proof (ODP) with a 1.15 service factor.

.2 Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.

.3 Sliding motor plate with adjustment screws to make belt tensioning operations.

.4 Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.

.5 Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.

.6 Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.

.7 Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class {Average Life or (L-50) of 400,000 hours}.

.8 Bearings shall have extended lube lines with Zerk fittings to allow for lubrication.

.9 Accessories

.1 Motor Cover: Weatherproof motor cover to protect the motor and drive components. Motor cover to meet OSHA guidelines and to be easily removed for service access.

.2 Belt Guard: Provide belt guards on all indoor, belt driven fans. Belt guards to include tachometer openings to monitor the fan speed as well as an access panel for testing belt tension. Belt guards to meet OSHA guidelines.

.2 Disconnect Switch: Provide a NEMA rated 3R rated disconnect switch wired from fan motor to junction box

.3 Shaft Guard: Provide shaft guards to cover shafts and bearings on arrangements 1, 8, or 9 configurations. Provide extended lube lines to allow for bearing lubrication without removal of the guard. Shaft guards meet OSHA guidelines.

.4 Inlet and Flanges: Provide inlet flanges on single-width fans are pre-punched and welded to the inlet collar.

.5 Drain with Plug: Provide a 25mm (1") threaded drain connection located at the bottom of the fan housing.

.6 Extended Lubrication Lines: Provide flexible nylon or copper tubing extending from the bearings to conveniently located grease fittings mounted on the fan pedestal or on the exterior of the motor cover.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 INSTALLATION

.1 Where inlet or outlet is exposed, provide safety screen.

.2 Provide belt guards on belt driven fans complete with tachometer access.

.3 Supply and install sheaves as necessary for final air balancing.

.4 Bearings and extension tubes to be easily accessible.

.5 Access doors and access panels to be easily accessible.

.6 Provide 100mm (4") high housekeeping base for floor mounted units.

3.3 PRIMING

.1 Prime coat fan wheels and housing factory inside and outside. Prime coating on aluminum parts is not required.

.2 Provide two additional coats of paint on fans handling air downstream of humidifiers.

3.4 PERFORMANCE

.1 Refer to Fan Schedule on drawings.

.2 Fan performance based on 910m (2985 ft) altitude.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Goosenecks

.2 Louvers

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Air Duct Cleaning for HVAC Systems	Section 23 01 31
.3	Hangers and Supports for HVAC Piping and Equipment	Section 23 05 29
.4	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.5	Metal Ducts – Low Pressure to 500 Pa	Section 23 31 13.01
.6	Air Duct Accessories	Section 23 33 00

1.3 REFERENCE STANDARDS

.1 ASTM International

  .1 ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.2 National Research Council Canada (NRC)

  .1 National Building Code of Canada – Alberta Edition 2019 (NBC(AE))

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.4 QUALITY ASSURANCE

.1 Outside louvers shall bear AMCA seal for free area and water penetration.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

  .1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit detailed shop drawings for louvers which clearly indicate, at a minimum, the following:

.1 Manufacturer and model

.2 Materials of construction

.3 Pressure drop

.4 Dimensions and free area of each louver

.5 Finish

.6 Submit color selection charts of finishes for approval prior to fabrication.

1.6 CLOSEOUT SUBMITTALS

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

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GOOSENECK HOODS

.1 Thickness: to ASHRAE and SMACNA.

.2 Fabrication: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA.

.4 Supports: as indicated.

.5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12mm (½“) mesh.

.6 Mount on 300mm (12”) high roof curb.

2.2 LOUVERS – STATIONARY

.1 Construction: Welded with exposed joints ground flush and smooth.

.2 Materials: Fabricate of 1.6mm (16 gauge) galvanized steel blades and frame.

.3 Materials: Fabricate of 2.0mm (14gauge) extruded aluminum blades and frame. Where openings exceed 1800mm (72”) in height, jamb frames shall be 2.0mm (14 gauge).

.4 Blade: storm-proof with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm (60”). Continuous blade appearance where specified.

.5 Frame, Head, Sill and Jamb: 100mm (4”) or 150mm (6”) deep one-piece extruded aluminum, minimum 3mm (0.12”) thick.

.6 Mullions: Spaced at 1500mm (60”) maximum centres, interior where continuous blade louvers specified.

.7 Fastenings: Stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, SS washer and aluminum body.

.8 Screen: Mesh 15mm (½”) diameter wire aluminum birdscreen on inside face of louvers in formed U-frame.

.9 Finish: Finish as noted on Louver Schedule on drawings. Color shall be selected by the Architect.

.10 Openings for non-rectangular louvers shall be field measured prior to ordering the louvers.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louver installation in accordance with manufacturer's written instructions.

3.2 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLATION

.1 Install louvers and goosenecks in accordance with manufacturer’s recommendations and in accordance with recommendations to SMACNA.

.2 Reinforce and brace air vents, intakes and gooseneck hoods for wind speed in accordance with the NBC(AE) for location.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.4 PERFORMANCE

.1 Refer to Louver Schedule on drawings.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Pleated filters

.2 High efficiency bag filters

.3 Air filter gauges

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Air Duct Cleaning for HVAC Systems	Section 23 01 31
.3	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.4	Metal Ducts – Low Pressure to 500 kPA	Section 23 31 13.01
.5	Air Duct Accessories	Section 23 33 00
.6	Air Handling – Built-up	Section 23 73 00.13

1.3 REFERENCE STANDARDS

.1 American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.1	ANSI/ASHRAE 52.2	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).

.2 Canadian General Standards Board (CGSB)

.1	CAN/CGSB-115.10	Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems
.2	CAN/CGSB-115.11	Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985)
.3	CAN/CGSB-115.12	Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985)
.4	CAN/CGSB-115.14	High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems
.5	CAN/CGSB-115.15	High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems
.6	CAN/CGSB-115.18	Filter, Air, Extended Area Panel Type, Medium Efficiency

.3 Underwriters' Laboratories of Canada (ULC)

.1 ULC -S111 Standard Method of Fire Tests for Air Filter Units.

1.4 QUALITY ASSURANCE

.1 Filters shall be product of and supplied by one manufacturer.

.2 Filter media shall be UL listed, Class I or Class II.

.3 Filter components assembled to form filter banks shall be products of same manufacturer.

.4 Filters shall be in accordance with ASHRAE Standard 52.2.

.5 Filters containing asbestos, urea formaldehyde or fibreglass shall not be acceptable.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC filters and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Filter shop drawings that show, at a minimum, the following:

.1 Manufacturer and model
.2 MERV rating
.3 Media

.2 Filter housing shop drawings that show, at a minimum, the following:

.1 Manufacturer and model
.2 Construction
.3 Dimensions
.4 Number of filters
.5 Leakage rate

1.6 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data:

.1 Submit list of individual manufacturer's recommended spare parts for equipment such as frames and filters, specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

1.7 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.1 Provide:

.1 Spare filters: in addition to filters installed immediately prior to acceptance, supply one (1) complete set of filters for each piece of equipment.

1.8 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management and disposal in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 Media: suitable for air at 100% RH and air temperatures between -40 to 50°C (-40 to 122°F).

.2 Number of units, size and thickness of panels as required for air handling equipment.

.3 Overall dimensions of filter bank, configuration and capacities as noted on drawing.

2.2 HIGH EFFICIENCY BAG FILTERS

.1 Media: The filter shall consist of high-density microfine glass media chemically bonded to a permeable media support backing forming a filter blanket. Stitching centers has to be sealed through the use of a foam based sealant that shall remain pliable throughout the life of the filter. Pockets shall be formed into tapered pleats supported by controlled media space stitching.

.2 Support: Support members shall include a galvanized steel header and galvanized steel pocket retainers. The header shall be bonded to the media to prevent air bypass. Individual pocket retainers shall be fastened with a mechanical crimp to lock individual pockets together. The media pockets shall be bonded to the pocket retainers to prevent air bypass. The frame shall form a rigid and durable support assembly. A filter to filter sealing gasket shall be installed on one of the vertical members of the filter header.

.3 The filter shall be Class II listed by UL.

.4 The filter shall have a MERV 13 rating when tested in accordance with ASHRAE 52.2.

2.3 HIGH EFFICIENCY MINI-PLEATED V-BANK FILTERS

.1 Filter media shall be lofted moisture resistant synthetic media formed into a uniform radial pleat. A welded wire grid, spot welded on one-inch centers and treated for corrosion resistance shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation.

.2 A biodegradable enclosing frame of Kraft board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

.3 The filter shall be Class II listed by UL.

.4 The filter shall have a MERV 13 rating when tested in accordance with ASHRAE 52.2.

2.4 PLEATED PANEL FILTERS

.1 Media: The filter shall be constructed of non-woven reinforced cotton-synthetic fibers. A diamond grid with 98% open area shall provide support for the media. The media shall be bonded to media support to ensure pleat stability. A rigid, moisture resistant heavy duty kraft board shall enclose the media. The filter pack shall be bonded to the inside periphery of the frame to eliminate air by pass.

.2 The filter shall have a MERV 8 rating when tested in accordance with ASHRAE 52.2.

2.5 AIR FILTER GAUGES

.1 Gauges shall be magnehelic gauges with 2% accuracy, nominal 100mm (4”) diameter, suitable for -6.7°C to 60°C (20°F to 140°F) ambient.

.2 Where the gauge is utilized in roof mounted equipment, the gauge shall be mounted in the control panel of the equipment or in an auxiliary heated cabinet.

.3 Factory produced metal sensing tips shall be utilized, equal to Dwyer A302 Series tips for insertion into the ductwork.

.4 Range: Maximum of 1.5 times final filter pressure drop.

.5 One (1) gauge for each bank of filters and filter position.

.6 Permanent markers for initial pressure drop and recommended final pressure drop.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 INSTALLATION

.1 Construct and install filters to prevent passage of unfiltered air. Provide felt, rubber or neoprene gaskets.

.2 Do not operate fan system connected to filter banks until filters (temporary or permanent) are in place. Provide new filters at take-over by the Owner. Replace filters used during construction.

3.3 FILTER GAUGES

.1 Install type as indicated across each filter bank (pre-filter and final filter), including those in air handling units, in approved and easy readable location.

.2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

3.4 REPLACEMENT MEDIA

.1 Replace media immediately prior to acceptance.

.2 Ensure filter media is new and clean, as indicated by pressure gauge, at time of acceptance.

3.5 PERFORMANCE

.1 Refer to air handling unit specification sections and schedules.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Manufactured vents and chimneys for gas fired equipment

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Hangers and Supports for HVAC Piping and Equipment	Section 23 05 29
.3	Heating Boilers	Section 23 52 00

1.3 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International)

  .1 CAN/CSA-B149.1-15 Natural Gas and Propane Installation Code.

.2 National Research Council of Canada (NRC)

  .1 National Building Code of Canada – Alberta Edition 2019 (NBC(AE))

.3 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

.4 Underwriters' Laboratories of Canada (ULC)

1.4 QUALITY ASSURANCE

.1 Vents, chimneys and accessories forming part of the venting system shall be ULC labeled.

.2 Comply with CSA B149.1-10 Natural Gas Installation Code

.3 Comply with the Alberta Building code.

.4 Comply with requirements of Appliance Listing.

.5 Installation to meet all requirements of the Provincial Boiler Inspection Branch.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

  .1 Submit manufacturer's instructions, printed product literature and data sheets for breeching, chimneys and stacks and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

  .1 Submit shop drawings that include, at a minimum, the following information:

.1 Manufacturer and model

.2 Thimble details

.3 Supports

.4 Rain caps

.5 Guy details

.6 Methods of sealing sections.

1.6 CLOSEOUT SUBMITTALS

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

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 SPECIAL GAS VENTING

.1 ULC labelled, 760°C (1400°F) rated.

.2 Sectional, prefabricated, double wall with mineral wool insulation with mated fittings and couplings.

.1 Liner: Stainless steel – Type 304

.2 Shell: Aluminized steel Type 304 stainless steel

.3 Outer seals between sections: To suit application

.4 Inner seals between sections: To suit application

.3 Provide all fittings necessary for installation including, but not limited to, elbows, adjustable and variance length sections, wyes, tees, drain tee caps, tapered increasers/reducers, step increasers/reducers, bucket drains, bellows joint, flange adapters, drain sections, insulated exit cones, open stack closure rings, stack caps, half channel bands, roof and wall thimbles, roof support assemblies, storm collars and flashings, flanges, supports, guides and guy components.

.4 The exhaust system shall be designed and installed to be gas tight and prevent leakage of combustion products into the building. The vent system shall be ULC tested and listed to 14.95 kPa (60” wc) internal pressure.

2.2 ACCESSORIES

.1 Cleanouts: bolted, gasketted type, full size of breeching, as indicated.

.2 Hangers and supports: In accordance with manufacturer's recommendations and SMACNA.

.3 Rain cap.

.4 Thimble

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for breeching installation in accordance with manufacturer's written instructions.

3.2 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLATION

.1 Do not penetrate flue gas chamber of vent with screws or mechanical fasteners.

.2 Install breeching with positive slope upward from appliance.

.3 Provide clearance for proper installation of insulation and clearance to combustibles.

.4 Suspend breeching using trapeze hangers at 1500mm (5'-0") centers.

.5 Support breeching independent of equipment served.

.6 Install thimbles where breeching penetrates roof. Pack annular space with heat resistant caulking.

.7 Extend breeching a minimum of 1.2m (4'-0") above roof.

.8 Install raincap on breeching outlet.

.9 Install flashing and counterflashing where breeching passes through roof.

.10 Provide for expansion and contraction of breeching.

.11 Provide full angle ring and two-point rigid pipe guys to support breeching above roof. Secure with anchors to structure. Co-ordinate installation with roofing contractor.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Boilers.

.2 Controls and boiler trim.

.3 Steam and condensate connections.

.4 Fuel connection.

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Vibration and Seismic Controls for HVAC Piping and Equipment	Section 23 05 48
.3	Identification for HVAC Piping and Equipment	Section 23 05 53
.4	Steam and Condensate Heating Piping	Section 23 22 13
.5	Steam Specialties	Section 23 22 14
.6	Breeching, Chimneys and Stacks	Section 23 51 00

1.3 REFERENCE STANDARDS

.1 Alberta Boilers Safety Association (ABSA)

.2 American Boiler Manufacturers Association (ABMA)

.3 American Society of Mechanical Engineers (ASME)

.1	ASME Boiler and Pressure Vessel Code	Section I – Rules for Construction of Power Boilers
.2	ASME Boiler and Pressure Vessel Code	Section IV – Rules for Construction of Heating Boilers
.3	ASME Boiler and Pressure Vessel Code	Section VIII – Rules for Construction of Pressure Vessels

.4 Canadian Standards Association (CSA Group)

.1	CAN1-3.1	Industrial and Commercial Gas-Fired Package Boilers.
.2	CSA B51	Boiler, Pressure Vessel, and Pressure Piping Code.
.3	CSA B149.1-15	Natural Gas and Propane Installation Code.
.4	ANSI Z21.13/CSA 4.9	Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.5 Electrical and Electronic Manufacturers Association of Canada (EEMAC)

1.4 QUALITY ASSURANCE

.1 Comply with Provincial Regulations and have CSA and CGA approval.

.2 Units shall be approved by Underwriter's Laboratories and bear CSA label.

.3 Boilers shall be constructed in accordance with ASME Section IV. Units shall bear ASME stamp and be registered.

.4 Comply with NFPA 70 for electrical components and installation.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

  .1 Submit manufacturer's instructions, printed product literature and data sheets for heating boilers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

  .1 Submit shop drawings that include, at a minimum, the following information:

  .2 Indicate on drawings:

    .1 General arrangement showing terminal points, instrumentation test connections.
    .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
    .3 Foundations with loadings, anchor bolt arrangements.
    .4 Piping hook-ups.
    .5 Equipment electrical drawings.
    .6 Burners and controls.
    .7 All miscellaneous equipment.
    .8 Flame safety control system.
    .9 Breeching and stack configuration.

.7 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.6 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data:

.1 Submit operation and maintenance data for heating boilers for incorporation into manual.

1.7 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

.2 Protect boiler package from damage by leaving factory inspection openings and shipping packaging in place until final installation.

.3 If stored outside prior to final installation, boiler package must be protected from the elements and ground water with tarps and blocking as needed.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 WARRANTY

.1 General Warranty: Boiler Package shall be warranted against defects in workmanship and materials for 12 months after start-up or 18 months from ship date, whichever shall be less.

.2 Thermal Shock Warranty: The boiler vessel shall be warranted for 25 years against thermal shock on a non-prorated basis.

Part 2 Products

2.1 GENERAL

.1 The boiler shall be constructed and assembled as a completely packaged unit ready for field connections to the steam supply, return connection, electrical power supply, fuel supply(s), relief valve discharge, Building Management System (BMS) controls and flue-gas vent.

.2 103 kPa (15 psi) steam boilers shall be manufactured in strict accordance with the ASME Low Pressure Boiler Heating Code, Section IV, and shall bear the ASME “H” stamp for a maximum working pressure of 103 kPag (15 PSIG).

.3 The boiler shall have no less than $0.46m^2$ ($5 ft^2$) of heating surface per boiler horsepower.

.4 A tube removal and replacement shall be demonstrated at time of start-up.

2.2 VESSEL AND TUBE CONSTRUCTION

.1 The boiler shall be constructed on a heavy steel frame.

.2 The boiler pressure vessel shall be provided with adequately sized upper and lower drums.

.3 A minimum of two downcomers shall be provided and shall be located inside furnace chamber to maximize proper thermal internal water circulation.

.4 The boiler steam drum shall be no less than 600mm (24”) O.D.

.5 The drum shall be provided with internals designed for providing steam quality in excess of 99%.

.6 Steel water tubes are to be 40mm (1½”) O.D., 2.4mm (0.095”) wall thickness, six-pass, flexible serpentine bend design, not subject to thermal shock damage.

.7 Individual water tubes shall be easily removable and replaceable without either welding or rolling.

.8 The boiler shall have no more than two tube configurations.

.9 The boiler shall be furnished with an adequate number of tappings and inspection openings to facilitate internal boiler inspection and cleaning.

2.3 FURNACE/COMBUSTION CHAMBER CONSTRUCTION

.1 Access to the furnace/combustion chamber is gained by a hinged access door(s) with an opening of no less than 660mm wide x 1575mm high (26" wide x 62" high) maximum to allow for inspection of the interior chamber and the burner head. All remaining panels shall be individually removable.

.2 All access panels shall be affixed to the pressure vessel frame and insulated with 50mm (2”) mineral fiber mono block and 50mm (2”) high temperature ceramic blanket insulation and be fully gasketed for pressurized firing.

.3 The furnace/combustion chamber shall be primarily of water-wall design with one side of removable panels.

.4 The stationary interior wall shall be lined with 50mm (2”) ceramic blanket insulation.

.5 The front and rear walls are insulated with 125mm (5”) mineral fiber mono block and 50mm (2”) ceramic blanket insulation.

.6 The floor beneath the tubes shall be lined with 50mm (2”) mineral wool insulation, 25mm (1”) mineral fiber mono block insulation and 50mm (2”) ceramic blanket insulation.

.7 The boiler furnace/combustion chamber and flueways shall be designed to operate at a positive 125 Pa (0.50” w.c.) at the boiler flue outlet.

.8 The boiler requires a “positive pressure” type metal flue.

2.4 JACKET CONSTRUCTION

.1 The boiler shall be complete with a metal jacket, 16 gauge, zinc-coated rust resistant steel casing, finished with a suitable heat resisting paint and shall be constructed on a structural steel frame and properly insulated with no less than 40mm (1½”) fiberglass insulation.

.2 Complete jacket and insulation shall be easily removable and reinstalled.

.3 The boiler shall incorporate individually removable jacket doors, with handles providing easy access to combustion chamber and access panels.

.4 The entire tube area shall be easily accessible for fireside cleaning.

.5 All appropriate controls where possible, shall be mounted on boiler front.

.6 Any external downcomers shall be provided with factory supplied insulation, jacketing and guards to prevent human contact to high temperature surfaces while boiler is operating.

2.5 STEAM BOILER TRIM

.1 The boiler shall be provided with the following trim and controls

.1 ASME Safety-Relief Valve(s)

.2 Steam pressure gauge

.3 Steam pressure control operator

.4 High limit safety control

.5 Water gauge glass

.6 Low water cutoff and feed pump control

.7 Auxiliary low water cutoff – probe type M/R

.8 Manual blowdown valves (surface or bottom)

.9 ULC and CSD-1 listed

.10 Hardware I/O points for BMS

.11 BACnet serial I/O points for BMS

2.6 GAS BURNER

.1 Provide a CSA listed, forced draft, fully modulating, automatic low NOx natural gas burner.

.2 Burner Housing:

.1 Cast aluminum burner housing, capable of hinging open to the left or to the right. Burner housing shall incorporate a flange safety interlock switch to prevent the burner from starting when in the open position. Burner housing shall incorporate a self-checking differential air pressure switch. The housing shall incorporate a large sight glass for viewing the flame and a removable cover to allow free access to serviceable components.

.3 Air Intake:

.1 Air intake shall consist of multiple aluminum air intake vanes on the suction side for combustion air regulation. Air louvers shall be controlled by a dedicated stepper motor having 900 settable increments from 90 angular degrees (open) to 0 angular degrees (closed). Air louvers shall be driven to the fully closed position during the “off” cycle to minimize draft losses. Air intake shall include sound attenuating material and a screen to reduce the likelihood of foreign material entering the blower.

.4 Combustion Head:

.1 Stainless steel alloy flame tube and diffuser assembly. Flame tube and diffuser assembly shall have a temperature rating of > 800°C (1470°F). Diffuser, ignition electrodes, mixing assembly and all serviceable components shall be accessible without need for burner removal. Combustion head shall be adjustable such that the pressure drop across the diffuser can be optimized to match the maximum firing rate of the burner. The gas butterfly valve shall be integral to the burner allowing the gas train to be connected to the left or the right of the burner. Gas butterfly valve shall be controlled by a dedicated stepper motor having 900 settable increments from 90 angular degrees (open) to 0 angular degrees (closed).

.5 Fan:

.1 Blower wheel shall be statically and dynamically balanced.

.6 Motor:

.1 Three phase TEFC blower motor fully compatible for use with variable frequency drive.

.7 Burner Management System:

.1 The burner management system shall integrate fuel/air ratio control, flame safeguard functions, load control and communications into one control system. The fuel/air ratio control system shall be free of linkages which connect fuel control and air control functions into a common servomotor or actuator. Fuel and air control components shall be individually controlled by dedicated stepper motors programmable via the keypad.

.2 The burner shall have an ignition position independently configurable for best light-off.

.3 All functions including burner history, commissioned values, operating parameters and pressure temperature settings shall be accessible / adjustable without the need for laptop computer or other special tools. Burner management system shall have four levels of password protection. Both the programming pad and main control module shall hold the programmed data with capability of uploading / downloading from one to the other.

.4 The fuel air ratio shall be infinitely adjustable throughout the firing range.

.5 Flame safeguard system shall be integrated into the control system and shall include ionization rod.

.6 Combustion control system shall include inbuilt PID pressure / temperature control and time / temperature adjustable cold start function to protect the boiler from thermal shock.

.7 Control system shall have selectable operating modes to allow for the following:

.1 Direct modulation via the BMS using either a 4-20 mA, 0-10V or floating point operating signal.

.2 Set-point adjustment via the BMS using either a 4-20 mA, 0-10V or floating point operating signal. This shall be the default setting.

.8 The burner control system shall be capable of providing data signals via a serial BACnet interface.

.9 Control system shall incorporate a 4-line, 64 character LCD display. The display shall be capable of being mounted on the burner. The display shall be easy to remove from its mounting while remaining connected to the wiring harness enabling a technician to have “hand held” adjustment capability.

.8 Performance:

.1 The turndown ratio shall be a minimum of 5:1 for gas firing. The O_2 level shall be a maximum of 3% at high fire and 4.5% at low fire. CO shall not exceed 20 ppm for gas firing at all rates.

2.7 CONTROL PANEL AND ACCESSORIES

.1 Motor Starter Box: Includes DOL starter and overload, on/off switch with integrated burner on light and fault reset push button with integrated fault light.

.2 Modulating Controller: Compact PID modulating controller mounted directly on the burner cover. Dual color segmented LED display.

.3 Pressure Transducer: All ranges, max. 10,342 kPa (1500 psi).

2.8 GAS TRAIN

.1 Fully assembled gas fuel train complete with the following components:

.1 Manual shut-off ball valve

.2 Motorized safety shut-off valve with P.O.C. switch

.3 Combination motorized safety shut off valve with regulator and P.O.C. switch

.4 High & low gas pressure switches with manual reset switch

.5 2nd low gas pressure switch with relay timer

.6 Wired with liquid tight conduit to a terminal box mounted directly on the valve train

.7 Gas train to be pressure tested prior to shipping The following controls shall be furnished.

2.9 BOILER INTERFACE TO BUILDING MANAGEMENT SYSTEM

.1 The following hardware I/O points shall be available to the BMS.

.1 DO point from BMS to boiler for boiler Enable/Disable

.2 AO point from BMS for steam supply pressure set-point

.3 DI point from boiler to BMS for common alarm

.2 The following software I/O points shall be available to the BMS via the serial interface.

.1 Load signal

.2 Operating information

.3 Actual load position of burner

.4 Lock-out with failure code

.5 Actual position (on/off) of air pressure switch, gas pressure, flame supervision, valves, fan

.6 Start-up counter

.7 Actual operating hours

2.10 SPARE PARTS

.1 Boiler Manufacturer shall provide one spare boiler burner ignitor and one spare flame sensor.

2.11 BOILER FEED SYSTEM

.1 The boiler feed system shall have the storage capacity to overflow of at least 3.8 liters per 9.8 kW (1 gallon per 1 boiler horsepower) of the boiler(s) it is servicing. The boiler feed pumps shall be supplied with the boiler feed system and be capable of pumping twice the evaporation rate of the boiler at 3% above the boiler relief valve setting per the ASME code. The boiler and the boiler feed system shall be supplied by the same manufacturer to obtain single source responsibility.

.2 The storage tank shell and heads shall be constructed of 6mm (¼") thick minimum carbon steel to the specifications of SA516 Grade 70 or SA53B and shall be capable of holding the specified gallons to overflow. The horizontal vessel will be supplied (at a minimum) with 75mm (3") threaded connections for condensate return and vent, pump suction coupling of adequate size, a manual fill connection, overflow connection, drain connection, a sight glass with brass valves installed, and a blowout opening properly designed to keep the pressure in the tank at atmospheric conditions. All exposed metal surfaces shall be protected with a suitable heat and rust resisting paint. The base shall extend in front of the storage vessel for pump mounting and easier access to the pump(s) for inspection and maintenance.

.3 The boiler feed system is to be fully trimmed by the manufacturer including the following items:

.1 Make-Up Water Assembly: A mechanical float-type make-up water control shall be provided to accept incoming water up to a differential pressure of 700 kPa (100 psi). The make-up valve assembly shall mount directly into the tank to eliminate unnecessary external piping and be removable from the outside of the vessel for easy maintenance and inspection. The make-up valve shall be made of brass or bronze with a copper float that does not require external power for operation.

.2 Misc. Gauges: A temperature gauge shall be supplied and installed by the manufacturer. The gauge shall be sized suitable for the operation and design range of the boiler feed system. A gauge glass shall be supplied and installed to indicate the water level in the tank. The gauge glass shall be protected from objects by metal protectors and have shut off valves on both ends.

.3 Steam Pre-Heater Assembly, complete with combination pressure/temperature valve, stainless sparge tube, “Y” strainer and gate valve.

.4 Stainless Steel chemical feed quill.

.5 Apexior tank lining.

.6 Insulated jacket.

.4 The boiler feed system shall be supplied from the manufacture with a pump package which shall include the following:

.1 Stand: The storage tank shall be supported by two saddles that are attached to four legs made of 50mm (2”) standard diameter pipe to supply enough net positive suction head required for the pumps plus additional safety factor to avoid cavitation. The unit and pumps shall be mounted on a 100mm (4”) channel structural steel base with a minimum 6mm (¼”) thick steel plate floor with proper support and braces. All exposed metal surfaces shall be protected with a suitable heat and rust resisting paint.

.2 Pump(s): Pump size shall be based on pump schedule and be able to pump into the boiler at least 3% above the boiler relief valve setting to satisfy the ASME code. The pump shall be a vertical multistage pump with stainless steel impellers and a minimum of 121°C (250°F) seals. The pump motors shall be 3-phase, TEFC motors. Provide pump by-pass orifice kit.

.3 Pump Mounting and Piping: The pump(s) shall be mounted to the base. The pump suction piping shall include a vortex breaker, gate valve, strainer, and flexible connector for each pump. Pump discharge piping shall include a liquid filled pressure gauge with shut-off valve and pump throttling valve. All suction and discharge components will be factory installed. Piping may be taken apart at the unions or flanges for shipment.

.4 Pump Electrical Components: The pump shall be supplied with a TEFC motor. Each pump shall have a thru-the-door (3-phase) pump disconnect switch, 3-phase protection by Class LPJ fusing or similar fuse, and a motor starter with overloads. A hand-off-auto switch and pilot light shall also be provided for each pump. All pump electrical components shall be wired and factory checked before shipment. A fused control circuit transformer shall also be provided to reduce the 3-phase supplied power to 120/1/60 for the control circuit. The complete boiler feed system will have single point electrical connection located in a ULC listed Nema 12 control panel. Liquid tight conduit shall be used between the panel and external electrical items mounted on the boiler feed system package.

2.12 BLOWDOWN SEPARATOR

.1 Furnish and install a blowdown separator. The ASME Section VIII, Div. 1 vessel is to be made of 406mm (16") diameter, 9.5mm (.375") thick minimum pipe and flanged and dished 9.5mm (.375") thick minimum high crown heads and stamped per the ASME Boiler and Pressure Vessel Code for 1034 kPag (150 psig) working pressure.

.2 The blowdown separator shall have a 16 gauge stainless steel striking plate starting at the point of inlet impingement and continuing until a third of the separator’s circumference is covered in order to reduce wear on the vessel. The striking plate is to be at least twice the height of the inlet diameter. Three 11 gauge stainless steel wall baffles and one 16 gauge spiral baffle also be installed near the bottom of the blowdown separator for quick and efficient drainage.

.3 The vent and drain connections shall be a 150# slip-on flange for sizes 75mm (3") and larger and a 3000# third coupling for sizes 65mm (2½") and smaller. The vent pipe shall extend in the middle of the vessel past the striking plate to help ensure dry venting to the atmosphere. The drain connection is to be flush with the inside of the head to avoid water accumulation in the separator.

.4 The blowdown separator shall be supplied as standard with a floor stand. The floor stand shall consist of three50mm 50MM (2" x 2") angle iron legs and a 75mm x 75mm (3" x 3") leg pad welded to each leg. The leg pad shall have a 14mm (9/16") diameter hole for bolt down installation. The floor stand will elevate the blowdown separator at least 762mm (30") to provide adequate height for an optional aftercooler and connection to the drain.

.5 Provide an aftercooler and automatic temperature regulating valve or slow-closing solenoid valve with aquastat with the blowdown separator.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.

3.2 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLATION

.1 Install in accordance with ASME Boiler and Pressure Vessels Code and Provincial regulations, except where specified otherwise, and manufacturers recommendations.

.2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.

.3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.

.4 Install boiler, blowdown separator and boiler feed system on 100mm (4”) high concrete pads larger than the equipment base according to manufacturer's written instructions and referenced standards.

.5 Pipe steam relief valve through roof with drip pan elbow piped to nearest drain.

.6 Pipe blowdown/drain to blowdown tank/floor drain.

.7 Natural gas fired installations: in accordance with CSA B149.1.

.8 Oil fired installations - in accordance with CSA B139.

3.4 MOUNTINGS AND ACCESSORIES

.1 Safety valves and relief valves:

- .1 Run separate discharge from each valve.
- .2 Terminate discharge pipe as indicated.
- .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

.2 Blowdown valves:

- .1 Run discharge to terminate as indicated.

3.5 FIELD QUALITY CONTROL

.1 Start-Up:

- .1 Manufacturer to:
  - .1 Certify installation.
  - .2 Start up and commission installation.
  - .3 Carry out on-site performance verification tests.
  - .4 Demonstrate operation and maintenance.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave Work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Custom air handling units.

1.2 RELATED REQUIREMENTS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Air Duct Cleaning for HVAC Systems	Section 23 01 31
.3	Common Motor Requirements for HVAC Equipment	Section 23 05 13
.4	Variable Frequency Drives for HVAC Equipment	Section 23 05 14
.5	Identification for HVAC Piping and Equipment	Section 23 05 53
.6	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.7	HVAC Cleaning Devices	Section 23 40 00

1.3 REFERENCE STANDARDS

.1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)

.1	ARI 270	Sound Rating of Outdoor Unitary Equipment
.2	ANSI/AHRI 430	Performance Rating of Central Station Air-Handling Units.

.2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)

.1	ANSI/ASHRAE 52.2	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
.2	ANSI/ASHRAE/IES 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings.

.3 Canadian Standards Association (CSA)

.1	CSA C22.1 HB	Canadian Electrical Code, Handbook.

.4 National Fire Protection Association

.1	NFPA 90A	Installation of Air Conditioning and Ventilating Systems.

.5 National Research Council (NRC)/Institute for Research in Construction.

.1 National Energy Code of Canada for Buildings (NECB) 2017

1.4 QUALITY ASSURANCE

.1 It is the intent of this specification that the manufacturer provide air handling units designed and manufactured specifically to the requirements of this project. Overall dimensions, and configuration are to be as shown on the plans and as described in the specifications. Take responsibility for the engineering and operational integrity of the air handling unit.

.2 Air handling units are to be built by a recognized manufacturer of air handling units who maintains a local parts and service agency.

.3 Unit construction shall be as per the construction details as described herein. Electrical installation shall comply with the requirements of Division 26, and the Canadian Electrical Code.

.4 Air flow rates, external static pressures, water flow rates, coil face velocities, filter face velocities, water and air side pressure drops shall be the same or better than specified, for equivalent selections.

.5 Fans shall be AMCA certified.

.6 Coils shall be AHRI certified.

.7 Filter media shall be ULC listed.

.8 All motors shall be provided with thermal overload protection.

.9 Construction shall comply with Provincial codes and shall have CSA approval.

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

.11 All components, paints, and lining shall have a flame spread rating of not over 25 with no evidence of continued progressive combustion and a smoke developed rating no higher than 50 as tested according to AN/ULC – S102.2 Standard Method of Test for Surface Burning Characteristics of Building Materials and assemblies.

.12 Sealing of all unit casing penetrations made on site such as for piping, conduit, hanger rods, etc. shall be the responsibility of the mechanical contractor to the satisfaction of the Air Handling unit manufacturer. Sealing method and components shall be suitable to withstand 1.5 times the working pressure of the unit.

.13 The following are to be equalled or improved:

- .1 Coil face velocities equalled or lowered
- .2 Filter face velocities equalled or lowered
- .3 Sound power levels equalled or lowered
- .4 Outlet velocities equalled or lowered
- .5 Water pressure drops equalled or lowered
- .6 Water flows equalled or lowered

.7 External static pressure equalled or increased without any increase in listed fan motor power requirements

.14 Units with factory wiring shall be factory UL/ETL/CSA approved and labeled. Failure to comply with this requirement shall necessitate the manufacturer at his expense to have a certified UL/ETL/CSA representative inspect the equipment prior to affixing a label.

1.5 FACTORY TESTING

.1 All air handling units shall have the following tests completed at the manufacturer's plant prior to authorization for shipment to the site.

.2 All air handling units shall be factory airflow tested to ensure it meets the specified airflow and external static pressure requirements. Tests shall be carried out in accordance with ASHRAE 51 / AMCA 210 Laboratory methods of testing fans for rating. Tests shall be with all filters in location, as specified. Manufacturing company shall certify test results and forward to the consultant. Test set-up shall be as per AMCA 210 Figure 7. Outlet duct setup – Pitot traverse in outlet duct.

.3 All air handling units shall be factory leak tested to ensure that the unit meets a SMACNA Seal Class “A”. The leak test shall be carried out at 150% of the total operating supply fan static pressure. Tests shall be carried out in accordance SMACNA HVAC Air Duct Leakage Test Manual. Tests shall be carried out with unit completely assembled and with duct connection locations sealed with temporary metal covers. Units shall be tested under positive and negative pressure conditions. Manufacturing company shall certify test results and forward to the consultant.

.4 All air handling units shall be factory sound tested to ensure units do not exceed specified sound power levels. In-duct sound power measurements shall be taken for all duct connections to the unit. Tests shall be carried out in accordance with ASHRAE 68 / AMCA 330 Laboratory method of in-duct sound power measurement procedure for fans. Tests shall be with all filters in location, as specified. Manufacturing company shall certify test results and forward to the consultant.

.5 In the event of a unit failing to meet the specified requirements, corrective action shall be taken by the manufacturing company to ensure that the units meet the specified requirements. Once corrective action has been taken, all tests described above shall be redone. The Engineer shall witness the retesting. If the corrective actions can not be completed and retested in the time originally scheduled for the initial test, the manufacturing company shall include all costs for the Design Engineer to return to the plant for the retest including travel expenses. The unit will not be authorized for shipment to site until such time as all testing listed above is proven to meet the specified requirements.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittals.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for air handling units and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings that show, as a minimum, the following information:

.1 Unit Dimensions: Indicated outside dimensional drawing including service clearances.

.2 Construction details: Submit unit construction drawings for the following components:

.1 Side panels, including connection details

.2 Top panel, including connection details

.3 Floor, including connection details

.4 Doors, hinges, latch, viewing port

.5 Fan, motor and drive, mounting and isolation

.6 Coil section

.7 Pipe and conduit penetration through casing or floor

.8 Drain pan

.9 Damper, linkage and drive construction and mounting

.10 Floor attachment to base detail.

.11 Structural base detail including intermediate channel locations.

.12 Floor seam welding detail.

.3 Materials of Construction: Indicate material and gauge of all construction components.

.4 Mass Distribution Drawings: Show point loads, and recommended methods of unit installation and lifting.

.5 Fan Performance Data: Submit fan performance curves as well as performance tables.

.6 Electrical voltages, phase and power requirements.

.7 Coils: Selection criteria indicating air side and fluid side capacities, in and out conditions, velocities, pressure drops and fouling factors. Submit a drawing showing headers, circuiting, arrangement, connection sizes, and materials of construction.

.8 Air Filters: Media, efficiency rating, velocity, pressure drop charts and capacities. Indicate mounting method and arrangement.

.9 Vibration Isolator Shop Drawings.

.10 Humidifier shop drawings and capacities. Refer to Section 23 84 13.

.11 Table indicating pressure drops through all components of the unit.

.12 Damper Shop Drawings. Outside air dampers shall be insulated and “R” value of the total damper as a unit shall not be less than 2.0 hr-ft^2-^{o}F/Btu.

.13 Detailed composite wiring diagrams showing factory installed wiring, including wiring of the control components.

.14 Sound Levels: Submit sound power levels generated by the air handling unit at the inlet and outlet of the unit and outside the fan section. List for individual octave bands in dB referenced to A rating.

.15 Neoprene lining specification including erosion resistance data.

.16 Variable frequency drive assemblies and motor shop drawings and data. Refer to Section 23 05 03, Electric Motors and Section 23 05 04, Variable Frequency Drives

.17 Manufacturer catalogue information for humidifiers and variable frequency drives.

1.7 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data:

.1 Submit operation and maintenance data for air handling equipment for incorporation into manual.

.2 Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.8 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.1 Spare filters: in addition to filters installed immediately prior to acceptance, supply 1 complete set of filters for each filter unit or filter bank.

1.9 DELIVERY & STORAGE

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

.2 Deliver products to site on a factory-installed base rail or shipping skid. Ship units over the road with 10 mil poly shrink-wrap.

.3 Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Units shall be heated and ventilated during storage.

1.10 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and dispose of waste materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

Part 2 Products

2.1 GENERAL

.1 Provide factory assembled air handling unit in configuration as indicated on the drawings. Unit shall include all specified components installed at the factory.

.2 The unit shall be designed to be supported by a house keeping pad or suspended. Refer to drawings.

.3 Units too large to be legally shipped on the road may be shipped to site in sections. Otherwise units shall be shipped in one piece.

2.2 COMPONENTS

.1 Air handling units shall consist of but not be limited to the following components:

- .1 Supply fan(s)
- .2 Heating coil
- .3 Cooling coil
- .4 Summer prefilter
- .5 Winter prefilter
- .6 Final filter
- .7 Steam grid humidifier
- .8 Access sections
- .9 Motorized dampers and actuators

2.3 CABINET

.1 Exterior Panels:

- .1 Minimum 1.6mm (16 gauge) satin coat galvanized steel with air dried enamel finish.

.2 Walls and Ceilings:

- .1 Interlocking construction with at least two breaks at each interlocking joint. Wall and ceiling joints to be broken inward. All panel joints to be caulked. Casing depth to match the specified insulation thickness. Inside surfaces shall be clean and flush, free of exposed flanges.

.3 Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, add addition internal reinforcing.

.4 Base:

.1 Construct from minimum 150mm (6”) structural steel channel iron around perimeter with intermediate channel and angle iron supports. Provide a 3.0mm (0.12”) thick aluminum checker plate floor in all sections of the unit. Provide floor bracing channels at maximum 300mm (12”) on centre. Maximum base deflection shall be 6mm (0.24”) on 6.10m (20 ft) unsupported span.

.2 Aluminum checker plate floor shall be welded to the floor bracing for rigidity. Drive screw attachment and caulking are not acceptable. Continuously weld the aluminum checker plate floor seams to ensure the floor is watertight.

.3 The base shall be provided with lifting lugs, a minimum of four (4) per unit section. The base shall be insulated with minimum 75mm (3”) fibreglass insulation and sheeted with a 0.85mm (22 gauge) galvanized steel liner. Floor that “oil can” are not acceptable.

.4 Provide a 38mm (1½”) perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as a drain pan and hold up to 38mm (1½”) of water.

.5 Provide auxiliary 30mm (1¼”) drains in fan sections downstream of cooling coils, and in mixing sections.

.6 All drain connections on floor mounted air handling units shall terminate at the side of the unit.

.5 Insulation and Liner:

.1 Insulate all exterior walls and roof with 100mm (4”) thick rigid fibrous glass acoustic insulation, 48 kg/m³ (3 lb/ft³) density. Line interior of all panels up to the final filter with 0.85mm (22 gauge) perforated galvanized steel liner. The inner wall downstream of the final filters shall be a minimum 0.85mm (22 gauge) solid galvanized steel liner

.2 Insulate underside of unit floor with 100mm (4”) thick rigid fibrous glass insulation 48 kg/m³ (3 lb/ft³) density.

.3 All insulation edges shall be protected with metal lagging. Insulation systems using stick pins or adhesives are not acceptable.

2.4 ACCESS DOORS

.1 Provide hinged man sized access doors. Access doors shall be manufactured from 1.61mm (16 gauge) galvanized steel. The doors shall be double wall construction with 0.85mm (22 gauge) solid metal liner on the inside. Corners of the doors shall be continuously welded for rigidity. 100mm (4”), 48 kg/m³ (3 lb/ft³) density insulation, shall be sandwiched between the 1.61mm (16 gauge) outer layer and the 0.85mm (22 gauge) inner layer. Doors must be the same thickness as the unit casing to maximize thermal and acoustical resistance.

.2 Doors shall be complete with 305mm (12”) diameter round double glazed hermetically sealed glass viewing window. Provide minimum two (2) cam-style latches per door openable from both sides. Door hinge to be a continuous stainless steel piano hinge. Doors to be sealed with automotive type 13mm (½”) closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame. Door frames shall be made from 16 gauge galvanized steel with the outside size of the door flush with the unit. Door sizes to be 610mm x 1800mm (24” x 72”) or as limited by height of unit. Fan compartments must have a door of minimum width to remove the motor.

.3 All access doors must swing against the air pressure.

2.5 FINISH

.1 Entire exterior is to be painted with two (2) coats primer paint followed by minimum two (2) coats of exterior application of air dried enamel.

2.6 MARINE LIGHTS

.1 Marine lights with protective metal cage and glass seals complete with duplex receptacles shall be installed on the wall across from the access doors. A switch with an indicator light shall be installed on the unit. Electrical power shall be 120V/1/60. Lights shall be equipped with compact fluorescent bulbs. Wiring for lighting shall be in rigid EMT conduit with rain tight fittings. A separate green bonding wire shall be provided. Each lighting circuit shall be 15A.

.2 Wire power connection in metal conduit to all lights and duplex outlets to one location for connection by Division 26. All wiring to be copper, minimum size #12 RW90.

.3 Light and duplex outlet power to be fed from a separate source so that the lights can operate when the unit is off.

.4 Provide electrical quick connects at each unit split to allow electrical contractor complete wiring between unit splits.

2.7 DRAIN PANS

.1 On units without stacked coils, provide a single fabricated, continuously welded, 1.6mm (16 gauge) Type 304 stainless steel drain pan under cooling coils. On units with stacked coils, provide a separate drain pan under each coil. On all units, provide a secondary drain pan extending under the entire access section downstream of the cooling coil, and the humidifier section. Provide a drain pan to drain the fresh air intake or mixing plenum. Pipe all drains to exterior side of unit.

2.8 FAN

.1 Acceptable Fan Manufacturers: Chicago, Northern Blower, Loren Cook, Twin City, Barry Blower, Greenheck.

.2 Fans to be as indicated on drawing details and drawing schedules. Centrifugal type fans to be complete with discharge evase. Fan to be both statically and dynamically balanced.

.3 Plenum fans shall incorporate a wheel, heavy gauge reinforced steel inlet plate with removable spun inlet cone, structural steel frame, and shaft and bearings in AMCA Arrangement 3 configuration as an entire assembly.

.4 All fan wheels shall have tapered spun wheel cones or shrouds providing stable flow and high rigidity. The wheels shall be non-overloading type.

.5 The blades shall be continuously-welded, die-formed Airfoil type, designed for maximum efficiency and quiet operation. Partial welding will not be acceptable on airfoil blades.

.6 Impellers shall be statically and dynamically balanced and complete fan assembly shall be test balanced at the operating speed prior to shipment.

.7 Shafts to be sized for first critical speed of at least 1.43 times the maximum speed for the class. Bearings are to be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for an L10 200,000 hour life at the maximum class RPM.

.8 Cantilevered vane blades are to be used through Size 490 to minimum air performance insertion losses and noise. Operating mechanism shall be out of the inlet airstream.

.9 Belt guards shall have sides of galvanized steel and faces of expanded metal. Provide a face on both the outside and the inside of the drive assembly. Provide openings in the faces for fan and motor tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes. Belt guards shall be in accordance with OSHA guidelines and fully enclose the fan belts.

.10 Plenum fan assembly must have an enclosed safety screen as per OSHA Standards.

.11 Fans shall have inlet OSHA approved inlet screens.

.12 Entire fan assembly including fan scroll, wheel and motor to be integrally mounted on an all welded, structural steel, prime coated, internal isolation base with springs selected to provide 99% isolation efficiency from the building structure. Structural base shall be separated from unit casing with flexible connections and spring isolators.

2.9 MOTORS

.1 Fan motors to be mounted and isolated on the same integral base as the fan.

.2 Fan motors shall be heavy duty, Design B, premium efficiency open drip-proof. Refer to Section 23 05 13 – Common Motor Requirements for HVAC Equipment. All motors to be by the same manufacturer.

.3 Motors used with variable frequency drives shall be provided with motor shaft grounding devices, a minimum insulation class of F, and shall meet NEMA MG1 Part 31.

.4 Fan drives shall be v-belt drive and shall have a constant pitch sheave for all motors. Horsepower shall be rated at 1.5 time the motor nameplate. A minimum of 2 belts shall be used for all motors greater than 3 HP.

.5 Provide variable sheaves for motors 11 kW (15 HP) and under and fixed sheaves for motors 15 kW (20 HP) and over. Exchange sheaves as necessary during balancing.

.6 Variable frequency drives to be provided by air handling unit manufacturer. Refer to Section 23 05 14 – Variable Frequency Drives for HVAC Equipment for requirements.

2.10 MOTOR REMOVAL BEAM

.1 The manufacturer shall provide a motor removal I-Beam in fan compartments with 18.6 kW (25hp) motors or larger. The motor removal I-Beam shall be a structural I-Beam capable of handling the safe removal of the motors in the fan compartment. The motor removal I-Beam shall be extendable to the outside of the air handling unit casing enabling the motor to be supported by the motor removal I-Beam to the outside of the unit casing. The manufacturer shall provide a removable casing access panel to allow for the extension of the motor removal I-Beam during motor removal.

2.11 VIBRATION ISOLATION

.1 Each fan and motor are to mounted on an all welded, structural steel, epoxy coated, internal isolation base, completed with open spring isolators with an internal isolation efficiency of at least 98**%** from the building structure.

.2 Isolators shall be free standing with sound deadening pads and leveling bolts.

.3 Spring diameter to compressed operating height ratio shall be 1 to 1.

.4 Spring deflection shall be a minimum of 50mm (2”).

.5 The outlet of the fan shall be separated from the unit casing by means of a factory installed flexible fabric connection.

.6 Manufacturer to provide independent data for internal isolation bases. If 98% efficiency cannot be met, cost of inertia bases shall be the responsibility of supplier.

2.12 FILTERS

.1 Refer to Section 23 40 00 – HVAC Cleaning Devices for detailed filter specifications.

.2 Filters containing urea formaldehyde or fibreglass are not acceptable.

.3 Prefilters: The filters shall be MERV 7 pleated, disposable types. Each filter shall consist of a non-woven cotton and synthetic fabric media, media support grid and enclosing frame.

.4 Prefilters shall be installed in prefabricated channel rack. Prefilters shall be lift-out where access is available upstream of the filter or slide out when access is not available.

.5 Final Filters: The filters shall be MERV 14, deep pleated, totally rigid and disposable type. Each filter shall consist of high density microfine glass fiber media, media support grid, contour stabilizer and enclosing frame.

.6 Holding Frames: Holding frames shall be factory fabricated of 16 gauge galvanized steel and shall be equipped with gaskets on all 4 sides of the filter and 2 heavy duty positive sealing fasteners. Each fastener shall be capable of withstanding 25 lbs. pressure without deflection and be attached or removed without the use of tools. Final filters shall be lifted out where access is available upstream of the filter, or side slideout when access is not available.

.7 Limit filter velocity based on face area to less than 2.5 m/s (500 fpm).

.8 Provide one Dwyer 2000 magnehelic filter gauge for each bank of filters, including for each position of prefilter. Flush mount gauge on the exterior of the unit. Magnehelic gauges shall be accurate to ±2% of full range.

2.13 COIL SECTION

.1 All coils shall meet or exceed all capacities specified on the mechanical schedule for the project. All coil performance shall be certified by the manufacturer in accordance with ARI Standard 410.

.2 Construct coils of configuration plate fins and seamless tubes. Copper fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

.3 Construct coil casings of minimum 16 gauge steel with formed end supports and top and bottom channels. Coils in cooling service shall have stainless steel casings and coils in heating-only service shall have galvanized steel casings.

.4 Coils shall be fully enclosed within casing and cooling coils shall be on mounted 304 stainless steel angle racks manufactured to allow coils to slide out individually. Heating coils shall be mounted on galvanized angle racks manufactured to allow coils to slide out individually.

.5 Removable coil access panels shall be provided to remove coils through casing wall. Coils shall be individually removable towards (away from) the access side. Coils must be individually racked, removable through the side access panels.

.6 Drain pans shall be continuously welded 304 stainless steel. Coil section must have intermediate drain pans and shall be interconnected with 25mm (1”) drain lines. Drain pans shall be IAQ sloped and fully drainable.

.7 Pipe connections shall be on the same end, extended through the casing for ease of connection, employing a plate over the connection to minimize leakage, and shall be threaded.

.8 On staggered coils, pipe connections shall be extended to the exterior of the unit using schedule 40 pipe. The pipe shall be supported with structural stands and the pipe clamped to the stands with 25mm (1”) thick thermally broken pipe clamps. For cooling coils, the support structure for the pipe extensions shall be made from stainless steel. Insulation of pipe extensions shall be provided by installer on site after installation.

.9 Water coils handling recently mixed air, or direct outside air, shall be drainable.

.10 Maximum heating and cooling coil face velocity to be 2.5 m/s (500 fpm).

.11 Water coils

  .1 Clearly label supply and return headers on outside of units such that direction of coil water-flow is counter to direction of unit air-flow.

  .2 Coils shall be proof tested to 2068 kPa (300 psig) and leak tested to 1379 kPa (200 psig) air pressure under water.

.3 Construct headers of round copper pipe. Construct tubes and fins of copper.

2.14 STEAM HUMIDIFIERS

.1 Air handling unit manufacturer shall furnish and install packaged steam injection type humidifier panel(s).

.2 Each panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Each tube shall be fitted with two rows of steam discharge tubelets inserted into the tube wall centered on the diametric line and spaced 40mm (1½”) apart. These tubelets shall be made of a non-metallic material designed for steam temperatures. The two rows shall discharge steam in diametrically opposite directions. Each tubelet shall contain a steam orifice sized for its required steam capacity. The humidifier shall provide absorption characteristics that preclude water accumulation on any plenum surfaces (within the absorption distance noted on the drawings schedules) downstream of the humidifier tube panel.

.3 Each packaged humidifier panel assembly of tubes and headers shall be contained with a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple panels in ducts or air handler casing.

.4 All tubes and headers shall be of 304 stainless steel and joints shall be heli-arc welded. Tubes shall be jointed to headers with slip fit couplers.

.5 The humidifier panels shall be furnished with appropriate steam valve, steam strainer and steam traps (when used), all shipped loose for installation on the job.

.6 Panels shall be pre-piped to exterior of casing.

2.15 DAMPERS

.1 Low leakage type dampers with hollow blades filled with extruded polyurethane insulation. Damper assembly shall have a thermal insulation value of R 0.35 °C/m2/W (2 °F/ft2/Btu); Tamco 9000 or equal.

.2 Blades shall be minimum 2.75mm (12gauge) extruded aluminium. Blades shall be of air foil design, 150mm (6”) wide. Maximum blade length 1200mm (4’-0”).

.3 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

.4 Frames shall be minimum 2.75mm (12 gauge) extruded aluminum channel with grooved inserts for seal.

.5 Install blade linkage hardware in frame out of air stream.

.6 Arrange linkage and provide an adequate number of damper operators to ensure that the interconnected damper sections operate in unison without binding.

.7 The outdoor and return dampers shall be integral part of the air handling units and shall be supplied and installed by the air handling unit manufacturer at the factory.

.8 Select outdoor and exhaust dampers at 5 m/s (1000 fpm) face velocity. Select return air damper for pressure drop similar to exhaust damper, ductwork and louvre.

.9 Damper operators shall be supplied by controls contractor and installed by the air handling unit manufacturer at the factory, in accordance with instructions from controls contractor. Extend drive and provide mounting bracket to place outdoor air actuators outside air stream where possible. Check unit and room height to ensure adequate space if extended through top of cabinet.

2.16 TEST PORTS

.1 Provide 25mm (1") diameter test ports for unit air stream testing in each plenum section between each component within the AHU. Test ports shall have a tube that extends between the inside and outside of the unit and a screwed cap on the exterior to allow access. The test ports shall have been flanged on the exterior to allow air seal and shall be flanged on the interior to cover the penetration of the casing.

2.17 ELECTRICAL

.1 Factory wire and test all air handling units. Have units approved by CSA, ETL or UL.

.2 Supply one (1) single point 575V/60 Hz/3 Ph power connection for each unit. Wire all 120 V/60 Hz/1 Ph components such as lights, convenience outlet, controls, heaters, etc. from a panel with circuit breakers for each type of electric device. Panel for 120 V/60 Hz/3 Ph is fed from a separate service.

.3 Label and number code all wiring and electrical devices in accordance with the unit electrical diagram. Mount the devices in a control panel inside the unit's service enclosure or on the outside. Ensure the control panel meets the CSA, ETL or UL.

.4 Provide a system of motor control including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, auxiliary contactors and terminals for the connection of external control devices or relays. Individually fuse all fan and branch circuits. On fans designated to be operated by Variable Frequency Drives, provide VFDs rather than contactors.

.5 Wire from the motors to the motor control in accordance with CSA, ETL or UL and contained by EMT conduit with liquid tight connections. Seal the casing penetrations in a manner that eliminates air leaks.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air handling unit installation in accordance with manufacturer's written instructions.

3.2 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLATION

.1 Pipe units to permit coil removal.

.2 Pipe units so water circuits are serviceable and coils can be removed without having to dismantle excessive lengths of pipe.

.3 Any piping or conduit passing through the unit casings must be sealed with rubber grommets and retaining plates to prevent air or water leakage.

.4 Insulate all piping as per Section 23 07 15 – Thermal Insulation for Piping.

.5 Entire air handling unit is to be levelled.

.6 Each drain connection shall be provided with a deep seal trap, and all connections piped to drain.

.7 Remove all internal hold-down bolts and shipping fasteners, and install any parts that were shipped loose. Level spring isolators.

.8 Check and re-align all access doors and dampers to ensure smooth operation through the entire range of travel.

.9 Upon start-up, each fan motor is to be checked for fan rotations, and amp draw for each phase.

.10 All belt drives are to be re-adjusted for tension and alignment.

.11 Provide a drain valve on each coil drain fitting, and a vent valve on each coil vent.

.12 The Contractor shall review all component sections for damage upon arrival to site, prior to acceptance for unpacking and reassembly. Any damages after unpacking are the responsibility of the Contractor.

.13 Gaskets and/or sealing components are to be supplied by the unit supplier. The reassembly of units shall be reviewed and instructed by supplier, to ensure factory quality reassembly.

.14 Contractor shall be responsible for onsite reassembly and onsite leak-testing of units as specified

3.4 FIELD ASSEMBLED AIR HANDLING UNIT

.1 The air handling unit shall be field assembled on site by the contractor. All parts shall be pre-formed by the manufacturer and partially assembled where access is possible. The parts shall be labeled according to an assembly drawing. All assembly material required such as insulation, sealants, fasteners and hardware shall be supplied by the manufacturer as part of the kit.

.2 Where access permits, sections of the exterior casing shall be pre-assembled in the factory. Otherwise, casing panels shall be shipped individually.

.3 The unit base shall be made in factory-assembled sections with joining flanges for field assembly. The base sections shall be pre-painted and pre-insulated in the factory.

.4 The doors and frames shall be pre-assembled (complete with windows where specified).

.5 Where access permits, the coil and filter racks shall be pre-assembled and pre-painted in the factory.

.6 The fan shall be assembled in the factory complete with motor, protective screening, belt guards and isolation base. The fan and guarding shall be pre-painted in the factory. The fan assembly shall undergo a test run in the factory. Where access permits, the fan assembly shall be shipped in one piece. If access does not permit shipping in one piece, the fan shall be disassembled and shipped in pieces.

.7 The manufacturer shall supply a representative to supervise the assembly of the air handling unit on the job site.

.8 The coils shall be installed on site by the contractor.

.9 The air handling unit shall be finish-painted on site by the contractor.

.10 The electrical panels shall be pre-assembled and pre-tested in the factory. The manufacturer shall provide all necessary conduits and fittings to extend the motor wiring to the electrical panel.

.11 The air handling unit manufacturer shall provide marine light fixtures, duplex receptacles, the light switch and the necessary conduit and fittings for field installation of the fixtures.

.12 All factory and field wiring and assembly shall be done in accordance with the National Electrical Code.

.13 The contractor shall be responsible for obtaining electrical approval of the final assembly.

3.5 PERFORMANCE

.1 Refer to Air Handling Unit Schedule on drawings.

.2 Refer to Coil Schedule on drawings.

.3 Refer to Humidifier Schedule on drawings.

3.6 CONFIGURATION

.1 Refer to air handling unit details on drawings for configuration of units.

3.7 ON SITE ALIGNMENT

.1 A qualified millwright shall confirm alignment of the fans and motors and submit a report for each. A vibration specialist shall perform vibration measurements on each fan/motor assembly at full operating performance. Adjustments in the fan balancing and alignment shall be conducted until the vibration measurements fall within the specified tolerances. Submit a report of the findings.

3.8 FIELD TESTING

.1 All air handling units shall have the following tests completed by the mechanical contractor on site prior to duct connection to the units. The Design Engineer and the representative of the manufacturer shall witness all testing. A minimum of five (5) working days notice shall be required prior to each site visit.

.2 All air handling units shall be leak tested to ensure that the unit meets a SMACNA Seal Class “A”. The leak test shall be carried out at 150% of the total operating supply fan static pressure. Test shall be carried out in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Tests shall be carried out with the unit completely assembled and with duct connection locations sealed with temporary metal covers. Units shall be tested under positive and negative pressure conditions. The manufacturing company shall certify test results and forward to the consultant.

3.9 START-UP

.1 In accordance with Section 21 05 01 – Common Work Results – Mechanical and with manufacturer’s recommendations.

.2 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.

  .1 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

.3 Provide equipment start-up reports for incorporation into O & M manuals.

.4 Commissioning Reports:

  .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports supplemented as specified herein. Include:

3.10 DEMONSTRATION

.1 Training: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O & M Personnel, supplemented as specified.

3.11 CLEANING

.1 Clean in accordance with Section 01 74 00 – Cleaning and Waste Management.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work area clean at end of each day.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for start-up, verification and commissioning, for Building Management System (BMS) and includes:

.1 Start-up testing and verification of systems.

.2 Check out demonstration or proper operation of components.

.3 On-site operational tests.

1.2 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - BMS: General Requirements.

.2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.3 Downtime: results whenever BMS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of BMS contractor. Downtime is measured by duration, in time, between time that BMS contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified BMS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.3 DESIGN REQUIREMENTS

.1 Confirm with Consultant that design criteria and design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret design criteria and design intents.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01330 - Submittal Procedures.

.2 Final Report: submit report to Consultant.

  .1 Include measurements, final settings and certified test results.

  .2 Bear signature of commissioning technician and supervisor

  .3 Report format to be approved by Consultant before commissioning is started.

  .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to BMS as set during commissioning and submit to Consultant in accordance with Section 01 78 00 - Closeout Submittals.

  .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.5 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Consultant before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.6 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

.2 Carry out commissioning under direction of Consultant and in presence of Consultant.

.3 Inform, and obtain approval from, Consultant in writing at least 14 days prior to commissioning or each test. Indicate:

  .1 Location and part of system to be tested or commissioned.

  .2 Testing/commissioning procedures, anticipated results.

  .3 Names of testing/commissioning personnel.

.4 Correct deficiencies, re-test in presence of Consultant until satisfactory performance is obtained.

.5 Acceptance of tests will not relieve BMS contractor from responsibility for ensuring that complete systems meet every requirement of the BMS contract.

.6 Load system with project software.

.7 Perform tests as required.

1.7 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Consultant.

1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

1.9 SYSTEM ACTIVATION

.1 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Consultant for approval.

.2 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.

.3 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, ***positioners***, etc., verifying that end to end calibration accuracy as specified has been achieved.

.4 Calibrate duct air flow stations provided under this contract at five (5) evenly spaced points across air flow range. Terminal box air flow stations need only be calibrated at points near their maximum and minimum (or occupied and unoccupied) air flow setpoints.

.5 Submit duct air flow station calibration reports showing measured and DDC readings for each calibration point and date of calibration. Identify in the report the instrumentation used for calibration including serial numbers and date of instrument calibration.

.6 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.

.7 Set damper linkages, static pressure/volume controls as required.

.8 Set up run time capture for each digital input point.

.9 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.

.10 Set up high and low alarm limit points for analog input points as shown on the point list.

.11 Provide alarm messages for the alarm points, with the alarm message to be obtained from the Owner and installed during the commissioning.

Part 2 Products

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios and/or cell phones.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Locations to be approved, readily accessible and readable.

Part 3 Execution

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Consultant.

.3 Commission integrated systems using procedures prescribed by Consultant.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

.1 Testing.

- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
- .2 Include following activities:
  - .1 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning
  - .2 Test and calibrate field hardware including stand-alone capability of each controller.
  - .3 Verify each A-to-D convertor.
  - .4 Test and calibrate each AI using calibrated digital instruments.
  - .5 Test each DI to ensure proper settings and switching contacts.
  - .6 Test each DO to ensure proper operation and lag time.
  - .7 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
  - .8 Test operating software.
  - .9 Test application software and provide samples of logs and commands.
  - .10 Verify each CDL including energy optimization programs.
  - .11 Debug software.
  - .12 Blow out flow measuring and static pressure stations with high pressure air.
  - .13 Provide
    - .1 Controller identification number

.2 Controller input/output point number

.3 Control point mnemonic

.4 A complete concise English description of each point

.5 Device controlled

.6 Interlock devices

.7 Measured and displayed analog input values

.8 Analog Output zero and full scale verification

.9 End to End verification for all points

.10 Wire labels verification

.11 Device tag verification

.12 Date of verification

.14 Provide above point verification list in table format. Include space on commissioning document for technician and Consultant. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Consultant and provide:

.1 Technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Consultant's acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final startup testing.

.5 O&M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel Consultant**.**

.7 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.8 Operate systems as long as necessary to commission entire project.

.9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that BMS functions in accordance with contract requirements.

.1 Prior to beginning of 7day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 7consecutive, 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 BMS equipment and software operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of BMS contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 Consultant to verify reported results.

3.3 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by Consultant, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

.1 Demonstrate to Consultant operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for training program, instructors and training materials, for Building Management System (BMS) work.

1.2 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - BMS: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, supplemented and modified by requirements of this Section.

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Consultant prior to anticipated date of beginning of training.

.1 List name of trainer, and type of visual and audio aids to be used.

.2 Show co-ordinated interface with other BMS mechanical and electrical training programs.

.3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.4 QUALITY ASSURANCE

.1 Provide competent instructors thoroughly familiar with aspects of the BMS installed in the facility.

.2 Consultant reserves the right to approve instructors.

1.5 TIME FOR TRAINING

.1 Number of days of instruction to be as specified in this section (1 day = 7.5 hours including two 15 minute breaks and excluding 1 hour lunch time).

1.6 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Supply manual for each trainee, describing in detail data included in each training program.

.1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.7 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.8 MONITORING OF TRAINING

.1 Consultant to monitor training program and may modify schedule and content.

1.9 OWNER ORIENTATION

.1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Consultant.

.2 Individuals who have had specific training as an instructor shall conduct training sessions.

.3 All training sessions shall include training materials and shall follow a documented course outline.

.4 A copy of the training materials, which shall include a detailed course outline shall be submitted to the Consultant for approval three weeks prior to commencing any training sessions.

.5 Any training conducted without prior approval of the Consultant shall be repeated at the discretion of the Consultant and/or will not count toward the BMS contractor's training obligations.

.6 The BMS contractor shall provide three weeks written notice to the Consultant and building Owner prior to commencing formal training sessions.

.7 The BMS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Consultant.

.8 Provide for operator training according to the following schedule.

- .1 A two (2) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
  - .1 Operation of hardware components
  - .2 System software configuration
  - .3 User/system interaction
  - .4 Calibration of sensors and system
  - .5 Trouble shooting of system and components
  - .6 Preventative maintenance
- .1 A two (2) day system and component familiarization seminar/workshop during the first week of trial usage and after successful completion of 7-day acceptance test. The days shall be separated by at least one day and shall be coordinated with the Owner.
- .2 A one (1) day review workshop at one month after system acceptance.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Modify the existing BMS to provide a complete system of Building Management System (BMS) controls for the systems referred to in this specification.

.2 The work includes the removal and relocation of existing BMS equipment, along with the supply and installation of new digital controllers, instrumentation, control devices, conduit, wiring, tubing and other devices as necessary to provide a complete BMS system, compliant with these specifications.

.3 Supply, install and configure all software, programming and databases; set up equipment operating schedules; and perform system activation functions as identified within these specifications, to provide a complete and fully operational BMS.

.4 BMS work involves renovations to an existing BMS system. The BMS Contractor shall inspect the systems prior to tender close and include in the submission all interlocks, relays, logic, sensors, etc. required to provide a fully operational BMS system.

.5 The BMS Contractor shall ensure the installation and commissioning of the BMS system shall not disrupt the use of the facilities.

.6 Prior to commencement of the site construction the BMS Contractor shall inspect the existing BMS system and provide a detailed listing of defective BMS equipment and components requiring replacement relevant to the new AHU units being installed. Items not identified at the time of inspection shall be the BMS Contractor's responsibility for replacement at no cost to the Owner.

.7 The BMS Contractor shall remove all abandoned or redundant BMS devices and cabinets, repairing and patching holes left by removed devices. Removed instruments and cabinets shall be turned over to the Owner and if they request, the BMS contractor shall remove the equipment from site and dispose as required.

1.2 RELATED WORK

.1	EMCS – Start-up, Verification and Commissioning	Section 25 01 11
.2	EMCS – Training	Section 25 01 12
.3	EMCS – Submittals and Review Process	Section 25 05 02
.4	EMCS – Project Record Documents	Section 25 05 03
.5	EMCS – Identification	Section 25 05 54
.6	EMCS – Field Installation	Section 25 05 60
.7	EMCS – Warranty and Maintenance	Section 25 08 20
.8	EMCS – Local Area Network (LAN)	Section 25 10 01
.9	EMCS – Operator Workstation (OWS)	Section 25 10 02
.10	EMCS – Building Controllers	Section 25 30 01
.11	EMCS – Field Control Devices	Section 25 30 02

.12 EMCS – Site Requirements, Applications and Sequences of Operation — Section 25 90 01

1.3 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).

- .1 ANSI/ISA 5.5- 1985 — Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

- .1 ANSI/IEEE 260.1- 1993 — American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

- .1 ASHRAE STD 135-R2016 — BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).

- .1 CAN/CSA-Z234.1-89(R1995) — Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).

- .1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

- .1 Material Safety Data Sheets (MSDS).

1.4 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:

- .1 AEL - Average Effectiveness Level.
- .2 AI - Analog Input.
- .3 AIT - Agreement on International Trade.
- .4 AO - Analog Output.
- .5 ASC – Application Specific Controller – Same as LCU, TCU
- .6 BACnet - Building Automation and Control Network.
- .7 BAS – Building Automation System – Same as EMCS, BMS
- .8 BC(s) - Building Controller(s) – Same as SCU, MCU
- .9 BECC - Building Environmental Control Centre.
- .10 BMS – Building Management System – Same as EMCS
- .11 CAD - Computer Aided Design.

.12 CDL - Control Description Logic.
.13 CDS - Control Design Schematic.
.14 COSV - Change of State or Value.
.15 CPU - Central Processing Unit.
.16 DI - Digital Input.
.17 DO - Digital Output.
.18 DP - Differential Pressure.
.19 ECU - Equipment Control Unit. – Same as ASC
.20 EMCS - Energy Monitoring and Control System. – Same as BMS, BAS
.21 HVAC - Heating, Ventilation, Air Conditioning.
.22 IDE - Interface Device Equipment.
.23 I/O - Input/Output.
.24 ISA - Industry Standard Architecture.
.25 LAN - Local Area Network.
.26 LCU - Local Control Unit. – Same as TCU, ASC
.27 MCU - Master Control Unit. - Same as SCU, BC
.28 NAFTA - North American Free Trade Agreement.
.29 NC - Normally Closed.
.30 NO - Normally Open.
.31 OS - Operating System.
.32 OIU – Operator Interface Unit – Same as OWS
.33 O&M - Operation and Maintenance.
.34 OWS - Operator Workstation. - Same as OIU
.35 PC - Personal Computer.
.36 PCI - Peripheral Control Interface.
.37 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.38 PID - Proportional, Integral and Derivative.
.39 RAM - Random Access Memory.
.40 SCU – System Control Unit – Same as BC, MCU
.41 SP - Static Pressure.
.42 ROM - Read Only Memory.
.43 TCU - Terminal Control Unit. - Same as LCU, ASC
.44 USB - Universal Serial Bus.
.45 UPS - Uninterruptible Power Supply.
.46 VAV - Variable Air Volume.
.47 WAN – Wide Area Network.

.2 In the specifications wherever an abbreviation is used, refer to the above where there are variations in the terminology, but application is the same.

1.5 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical/Serial points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Hardware Point Object Type: points fall into following object types:

.1 AI (analog input).
.2 AO (analog output).
.3 DI (digital input).
.4 DO (digital output).
.5 Pulse inputs.

.3 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer to Section 25 05 54- EMCS: Identification.

1.6 SYSTEM DESCRIPTION

.1 Work covered by sections referred to above consists of a fully operational BMS, including, but not limited to the following:

.1 Digital controllers.

.2 Control devices as listed in I/O point summary tables.

.3 Existing OWS(s) and/or access via Web Browser.

.4 Data communications equipment necessary to effect BMS data transmission system.

.5 Field control devices.

.6 Software/Hardware complete with full documentation.

.7 Complete operating and maintenance manuals for the new equipment.

.8 Training of personnel.

.9 Acceptance tests, technical support during commissioning, full documentation.

.10 Wiring interface co-ordination of equipment supplied by others.

.11 Miscellaneous work as specified in these sections and as indicated.

.2 Design Requirements:

.1 Design and provide conduit and wiring, linking elements of the BMS system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Consultant prior to installation.

.3 Location of controllers as reviewed by Consultant prior to installation.

.4 Provide 120/1/60 power and control wiring for total BMS as indicated.

.5 Metric references: in accordance with CAN/CSA Z234.1.

.3 Language Operating Requirements:

.1 Provide English operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.

.3 Operating system executive: provide primary hardware-to-software interface with associated documentation to be in English.

.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.5 Include, in English:

.1 Field related changes, Input and output commands and messages from operator-initiated functions, alarms as defined in CDL's or assigned limits (i.e. commands relating today-to-day operating functions and not related to system modifications, additions, or logic refinements).

.2 Graphic “display” functions point commands to turn systems on or off, manually override automatic control of specified hardware and software points. To be in English at specified OWS.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.7 ACTION AND INFORMATION SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittal and Review Process 01 33 00 - Submittal Procedures.

.2 Submit for review:

.1 Systems manufacturers Equipment list at time of tender.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Submittal and Review Process. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Consultant, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to Consultant.

1.8 WORK BY OTHERS

.1 Replacement and/or repair of existing BMS equipment identified from the BMS Contractor's inspection as defective.

.2 Provision of 120/1/60 emergency power circuits at the power panel locations or other specified locations as detailed herein.

.3 Distribution and installation of wells, flow insertion fittings, motorized valves and motorized dampers into the piping and ductwork systems.

1.9 QUALITY ASSURANCE

.1 The BMS equipment shall be Johnson Controls throughout and shall have service for the system from manufacturer's factory authorized service, resident in the City of Lethbridge.

.2 The following components shall be stocked locally:

.1 Replacement digital controllers to suit project
.2 Replacement transducers
.3 Replacement sensors and actuators

.3 Software engineering and support shall be resident in the City of Lethbridge.

.4 Have local office staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,

.5 Ensure qualified supervisory personnel continuously direct and monitor work and attend site meetings.

1.10 EXISTING BMS COMPONENTS

.1 The existing control wiring, piping may be used at the discretion of the BMS contractor, but warranty shall be included as if it was newly installed.

.2 Do not re-use existing sensors, actuators, valves, etc. installed on the existing AHU units; provide new sensors as required. Sensors downstream of the AHU units may be reused as required.

.3 Do not modify original design of existing devices without written permission from the Consultant.

.4 Inspect and test existing devices intended for re-use within 30 days of award of BMS contract, and prior to installation of new devices. Provide report to Consultant and receive approval from Consultant prior to re-use.

.5 Submit written request for permission to disconnect BMS controls and to obtain equipment downtime before proceeding with work.

.6 Assume responsibility for BMS to be incorporated into existing BMS after written receipt of approval from Consultant.

.1 Be responsible for items repaired or replaced.

.2 Be responsible for repair costs due to negligence or abuse of equipment.

.3 Responsibility for existing devices terminates the same time as new BMS components.

Part 2 Products

2.1 APPROVED BMS CONTRACTORS AND EQUIPMENT

.1 Tenders on the BMS system will only be accepted from the following specialty BMS contractor and manufacturer:

.1 Johnson Controls – Metasys

.2 There shall be no consideration for alternate manufacturers and/or specialty BMS contractors for this project.

2.2 GENERAL

.1 Maintain integrity of all fire protection and smoke evacuation systems.

2.3 BMS ARCHITECTURE

.1 The BMS system shall be native BACnet and shall be a continuation of the existing network.

.2 The BMS shall remain a standalone system for the building, with access to the system through standard web browsers, whether located within the building, on the client's LAN and/or WAN or outside the building over the Internet.

.3 The BMS shall be comprised of a network of interoperable, stand-alone digital controllers, operator workstations, updated server, graphical user interface software, network devices and other devices as specified herein.

.4 The BMS shall incorporate the ability to access all user interface functions as specified within these documents using standard internet browsers. Operator access to the BMS shall not require any proprietary operator interface or configuration software to be loaded on the respective PC and access shall only be limited by password.

.5 Provide for access to the BMS system by five (5) concurrent users, whether in the building or remote over the Internet.

.6 The BMS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2016 BACnet BTL compliant and labelled. The components shall be as outlined in Section 25 30 01 EMCS-Building Controllers and include:

- .1 Server – Updated server to latest hardware and software configuration, including Windows 10 operation.
- .2 Operator Workstation – BACnet I/P with Operator Workstation Software (B-OWS)
- .3 SCU – BACnet I/P with Building Controllers software (B-BC)
- .4 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)
- .5 Application Specific Controllers – BACnet MS/TP with Application Software (B-ASC)
- .6 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software

.7 The installed system shall provide secure multilevel password access to all features, functions and data contained in the overall BMS.

.8 Provide updated licenses for all software residing in the BMS system and transfer these licenses to the Owner, at no cost, prior to project completion. Provide software on CDs and/or DVDs and licenses for:

- .1 Database creation and editing
- .2 Engineering of the system
- .3 Service, Troubleshooting and/or Tool software
- .4 Graphics generation
- .5 Trending
- .6 Historical trending to cover all hardware and software points
- .7 Long term historical storage
- .8 Mapping of database into the existing BMS network

.9 With the CDs and/or DVDs as noted above it shall not require the Owner to obtain any information, data, programs, etc. from the manufacturer and shall not require access over the internet to the manufacturer’s site to perform the functionality. Provide 3 copies of the above CDs and/or DVDs.

.10 Downloading and Uploading

- .1 Provide the capability to generate BMS software-based sequences, database items and associated operational definition information and user-required revisions to same, at any Operator PC, and the means to download same to the associated controller.
- .2 Application software tool used for the generation of custom logic sequences shall be provided to the owner as part of this project.
- .3 Provide the capability to upload BMS operating software information, database items, sequences and alarms to the designated server.

Part 3 Execution

3.1 BMS SERIAL CONNECTIONS TO 3RD PARTY EQUIPMENT

.1 General

.1 For each mechanical or electrical system or piece of equipment the BACnet serial points shall be in addition to the hardware points listed in the points schedule. The point schedules do not indicate any software, serial BACnet points; only the hardware I/O points are listed.

.1 The BACnet serial points shall not be substituted for the hardware I/O points as listed in the points schedule.

.2 As indicated below the quantity of BACnet serial points shall be integrated into the graphics for the respective system and shall be updated in a similar manner as the hardware I/O points. The remaining BACnet serial points (not listed below) for each serial connection shall reside in a textual file, accessible from the Workstation and continuously updated.

.3 All the connections to 3rd party equipment shall utilize BACnet serial connections.

.4 In each case the full complement of variables shall be brought in to the BMS system in textual format; for each system the Owner and Engineer shall review the requirement based on the individual manufacturer's equipment.

.2 VFDs

.1 Allow for 5 additional software BACnet serial points per VFD. This shall also apply to VFDs supplied as part of any package equipment and is in addition to any BACnet serial points of the specific package equipment.

.3 Boiler

.1 Allow for 10 additional software BACnet serial points

3.2 VFDS

.1 Each VFD shall be complete with a BACnet MS/TP serial connection in addition to the discrete hardware points as listed in the points schedule. Each VFD shall be complete with a digital display for data entry and viewing operating parameters.

3.3 BOILER

.1 The boiler shall be complete with hardware points and a BACnet serial connection. In addition, the boiler package shall be complete with hardware sensors to allow total control from the boiler control panel. The BMS shall enable the boiler and provide a steam setpoint to the controller integral in the boiler.

3.4 ELECTRICAL WORK

.1 The BMS contractor shall supply and install all line and low voltage power and control wiring for the BMS system, including all 120/1/60 power wiring to power the various BMS components. The 120/1/60 power shall be extended from circuits currently utilized on this project at the BMS panel locations.

.2 All the electrical work for the BMS system shall be in accordance with the Electrical specifications, including size and type of wire, junction boxes, conduit installation, fittings, color coding, identification, etc.

.3 All conduit shall be banded, couplings shall be painted orange and all junction boxes shall have covers painted orange with the lettering ‘BMS’ painted black.

.4 For each 120/1/60 motor that is controlled from the BMS, the BMS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BMS contractor supplying and installing the control wiring to the BMS system. Devices shall be as manufactured by Functional Devices, RIBT series with separation between the line and low voltage wiring.

.5 The BMS contractor shall reuse the 120/24 transformers, power supplies and UPS units for the BMS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BMS equipment.

3.5 END SWITCHES

.1 The end switches and/or analog outputs provided on each damper or valve actuator shall be utilized as status for the attached damper or valve.

On two position motorized dampers or valves with multiple actuators each individual damper or valve actuator’s end switch shall be connected to the BMS and all the end switches must prove closed (or open) before allowing the sequence to operate.

3.6 AIR HANDLING UNITS

.1 The units providing ventilation air to the complex shall not be provided with a digital control system to provide control of the unit; the necessary digital controllers, sensors, transducers, etc. shall be supplied and installed by the BMS contractor.

.2 Flow rings supplied and installed on each fan as part of the AHU unit, complete with transducers shall provide a 0-10 VDC/4-20 ma linear signal to the BMS representative of the air flow.

.3 The supply and installation of motorized dampers and damper actuators shall be part of the AHU unit.

3.7 EXHAUST FANS

.1 Refer to the points list for exhaust fans that are controlled. Provide separate control and monitoring of fans for each typical application.

3.8 DIGITAL CONTROLLERS

.1 The existing FEU controllers for the AHU units being upgraded shall be replaced with new FEC/FAC controllers. The FEU controllers being removed shall be retained to provide service for any remaining FEU controllers on site.

3.9 EXISTING REMOTE SENSORS

.1 The remote sensors and transducers utilized in the overall control of the AHU units may be reused but shall be recalibrated, checked for operation and be warranted as for the new sensors. The BMS contractor shall allow in the basic tender for replacement of any sensors deemed unsatisfactory during the initial review of the BMS system.

3.10 CENTRAL DIGITAL HARDWARE AND SOFTWARE

.1 As part of the upgrade the existing ADX server shall be replaced and provide the new software and firmware functionality as outlined in Section 25 30 01.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Submittals of proposed BMS system.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1 Comply with requirements of Section 23 05 06 – Demonstration and Owner's Instruction for HVAC Systems.

1.3 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following BMS contractor and systems information.

- .1 Location of office.
- .2 Description and location of installing and servicing technical staff.
- .3 Location and qualifications of programming design and programming support staff.
- .4 Names of sub-contractors and site-specific key personnel.
- .5 Sketch of site-specific system architecture.
- .6 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
- .7 Descriptive brochures.
- .8 Sample CDL and graphics (systems schematics).
- .9 Response time for each type of command and report.
- .10 Item-by-item statement of compliance.
- .11 Proof of demonstrated ability of system to communicate utilizing BACnet protocol.

1.4 ACTION AND INFORMATION SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within 30 working days after contract award, for review by Consultant.

.3 Shop Drawings to consist of 1 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

.4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.5 Soft copy to be in AutoCAD - latest version or WordPerfect latest version or Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.5 SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels [for equipment to be supplied by others].

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Complete Point Name Lists.

.5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.6 Software and programming details associated with each point.

.7 Manufacturer's recommended installation instructions and procedures.

.8 Input and output signal levels or pressures where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of BMS.

.7 Graphic system schematic displays of air water systems with point identifiers and textual description of system, as specified.

.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.

.9 Listing and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator workspace.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.6 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations". BMS contractor to be fully conversant with project and explain sequence of operations of various systems i.e. not just repeating what is in the specification.

.2 BMS contractor's programmer to attend meeting.

.3 Consultant retains right to revise sequence or subsequent CDL prior to software finalization without cost t***o*** Owner or Consultant.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for Building Management System (BMS) work.

1.2 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Submit As-built drawings, Operation and Maintenance Manual, Record Documents in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.

.1 Binders to be 2/3 maximum full.

.2 Provide index to full volume in each binder.

.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:

.1 Changes to Contract Documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and control air lines associated with BMS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review *by* Consultant.

.3 Provide before acceptance 1 Hard and 1 soft copy incorporating changes made during final review.

1.5 RECORD DRAWINGS

.1 Before the certification of substantial performance will be issued the BMS contractor must provide the Consultant with record drawings as follows:

.1 One electronic copy of record drawings in AutoCAD version 2000 or Visio format.

.2 Four (4) copies of as-built white prints in 280mmx432mm (8½" x 17") capacity blue binders bound in heavy fabricated, hot stamped in white lettering front and spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.

.3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:

.1 Full identification title of the project

.2 Prime Consultant and Sub-Consultant - full identification

.3 Prime Contractor - full identification

.4 Mechanical Contractor - full identification

.4 Maintain an accurate record of all deviations and changes on a record drawing set of prints. Such record is to be maintained on a day-to-day basis.

.5 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

1.6 SYSTEM DOCUMENTATION

.2 Operating and Maintenance Manuals

.1 The BMS Operation and Maintenance Manuals shall contain operational, product data, cleaning and maintenance information on all products and equipment supplied as part of this projects BMS. The final Manuals shall accompany the Project Record Drawings and shall be in place prior to substantial performance.

.2 Submit a draft Manual for format review three (3) months after award of BMS contract and three (3) Manuals of Documentation for interim submission at 75% construction. Draft Manuals are to be complete in all aspects less control programming. Interim submission is to include all control shop drawings, programming and system descriptions. Draft and Interim Manuals are to be submitted in 3 ring binders. Final Manuals to be in catalogue type binder.

.3 Each manual shall be 215 mm x 280 mm capacity extension type Catalogue Binder bound in heavyweight fabricord, colour to be reviewed with the Owner prior to order and hot stamped in white lettering front and spine.

.4 The spine and front face of the binder shall be lettered with the following:

.1 Full identification title of the project

.2 Building Automation System

.3 Operation and Maintenance Manual

.4 Set X of Y

.5 Volume X of Y

.5 The manual shall be arranged according to the following format. Utilize colour coded laminated mylar plastic divider tabs with headings according to section.

.1 Table of Contents

.2 Introduction

.3 Control System Design

.4 Building System Descriptions

.5 DDC Panel Layout

.6 Shop Drawings

.7 Equipment Schedules

.8 Certification and Testing

.9 Product Manuals

.10 Maintenance

.11 Software & Certificates

.6 On the first page of each binder, before the table of contents identify the following:

.1 Prime Consultant: name, address, telephone number.

.2 Contractor: name, address, telephone number.

.3 Subcontractors: name address, telephone number.

.7 Table of Contents

.1 Include in each binder a table of contents that provides an index in order of appearance of all sections and subsections within the manual.

.8 Introduction

.1 Provide a written explanation of the layout of the manual.

.2 List all other control system manuals submitted for this project including all software manuals and hardware manuals. Identify the quantities of each manual provided.

.9 Control System Design

.1 Design Intent

.1 Explain, in this section, the design intent and give a system overview which outlines the relationships between the hardware, operating system, control software and other control components.

.2 Provide a detailed description of all parts, components and software in the system.

.3 Describe the system architecture. Provide a system configuration schematic with the location, type and model of all control panels, work stations, remote access modems, etc. and identify the major equipment monitored and controlled by each panel.

.4 The schematic must identify network communication protocols and communication speeds between all control panels and indicate BACnet compatibility where applicable.

.5 Identify the number of controllers that can be added to each network and sub-network and any maximum distance between controllers or maximum length of network without the need to add additional communication devices.

.6 Identify all software products provided including third party software. This shall include but not be limited to all operator workstation, graphics, controller and laptop software. For each product, indicate the number of software licenses provided, the name of the respective vendor and any software protection devices required. Indicate the number of software protection devices provided.

.2 Operations

.1 Provide an overview of the BMS operations. Include basic instruction on:

1. System access
2. Alarms management (including, how and where alarms are annunciated, after-hours reporting of critical alarms, etc.)
3. Commonly used reports
4. Laptop, local and remote system access and
5. Basic trouble shooting directions.

.2 These instructions are to provide a basic understanding of the system operations and are to reference specific areas of the software manuals for further detailed instructions.

.3 Provide detailed back-up and data recovery procedures including recommended frequencies and data to be backed up. Here again refer to specific areas of product manuals where appropriate. Provide sample back-up log sheets.

.10 Building System Descriptions

.1 System Design intent - Explain, in this section, the design intent and give a system overview which outlines the system components and the intended system function.

.2 Provide a schematic, control sequences, wiring diagram, device list and points list for each building system controlled by the BMS.

.3 Control sequences shall identify start-up and shut-down sequences, control loop set-points, reset schedules, system interlocks, etc.

.4 As built record drawings in 11” X 17” format, folded to fit into the O&M binders may be used to provide part or all of the information required for this section.

.11 DDC Panel Layout

.1 Provide as-built panel layout sheets and include locations of all panels.

.2 Include a panel points list that identifies each point name with concise English description and termination point. Identify panel spare points.

.3 Identify power source for each panel including emergency/normal, UPS, panel number and circuit number.

.12 Shop Drawings

.1 Insert in this section all approved shop drawings organized in the format specified in section 23 05 00 – Common Work Results for HVAC.

.13 Equipment Schedules

.1 Provide an equipment schedule for all hardware provided including valves, dampers, actuators, controllers, transducers, input/output devices and other instrumentation.

.14 Certification and Testing

.1 Provide final copies of all completed calibration and verification check sheets including all airflow station calibration check sheets.

.15 Product Manuals

.1 Include in this manual or within product, user manuals and technical manuals, complete and detailed instruction on the use, setup and support of all control system software and hardware provided under this project.

.2 Provide detailed instructions on set-up and user operations including but not limited to system access, navigation, alarms, trending, historical trending, reporting and trouble shooting.

.3 Provide complete detailed instruction on database structure, set-up, initialization, expansion and editing.

.4 Provide complete detailed instruction to enable creation, modification and implementation of control sequences.

.16 Maintenance

.1 Provide a description in this section of maintenance procedures for all equipment and systems, as defined in this specification, including a schedule for recommended planned and preventative maintenance work items and intervals.

.2 Include a preventative maintenance program complete with suggested check list sheets.

.3 Provide a list of resources to call upon for maintenance and servicing of equipment which includes name, address and phone numbers for supplier and service contact for each piece of equipment.

.4 Include in this section a complete set of as-built drawings if not included elsewhere in this manual.

.5 Certification, guarantee, warranty.

.17 Software & Certificates

.1 Provide original copies of all software distribution media on CDs inserted into vinyl page holders that are designed for 3 ring binders. The originals are to be provided in “Set 1” of these O&M manuals and back-up copies are to be provided in “Set 2”.

.2 Provide software registration certificates, or other documents that verify authenticity of software.

.3 Provide back-up copies of entire system at the time of system turn over on CDs in vinyl CD page holders designed for 3 ring binders. Backup to include complete control sequence source code.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for Building Management System (BMS) work and nameplates materials, colours and lettering sizes.

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).

CSA C22.1- 02	The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.5 ACTION AND INFORMATION SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Consultant for approval samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes*:* 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by plastic tie.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high produced from laser printer in black.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Consultant.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install colored signs warning of automatic starting under control of BMS.

.2 Sign to read: "**Caution: This equipment is under automatic remote control of BMS**".

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Color coding: to CSA C22.1*.* Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each BMS panel.

2.6 PNEUMATIC TUBING

.1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

.1 Color code BMS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm color with Consultant during "Preliminary Design Review".

Part 3 Execution

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during Work.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Division 26 - Electrical

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)

ANSI/ASME B16.22- 2013	Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
ANSI C2- 1990	National Electrical Safety Code.
ANSI/NFPA 70- 1990	National Electrical Code.

.2 CSA Group

CSA C22.1- 12	Canadian Electrical Code

1.3 SYSTEM DESCRIPTION

.1 Electrical:

- .1 Provide
  - .1 Power wiring from existing BMS panel circuits.
  - .2 Line and low voltage control wiring between field control devices, mechanical equipment, etc. and BMS field panels.
  - .3 Line and low voltage control wiring between loose control devices of mechanical equipment and the control panel of the mechanical equipment.
  - .4 Communication wiring between mechanical equipment control panels, remote sensors and BMS digital panels.

.2 Mechanical:

- .1 Pipe taps required for BMS equipment will be supplied and installed by Division 23.
- .2 Wells and control valves shall be supplied by BMS Contractor and installed by Division 23.
- .3 Installation of air flow stations, motorized dampers, and other devices requiring sheet metal trades to be mounted and installed by Division 23.

.3 Structural:

- .1 Special steelwork as required for installation of work.

1.4 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

- .1 Continuously direct and monitor all work.
- .2 Attend site meetings.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: refer to Section 01 73 00 - Execution supplemented as specified herein.

.2 Repair all surfaces damaged during execution of work.

.3 Turn over to the Owner existing materials removed from work not identified for re-use. If Owner does not require the equipment, allow for removal from site.

Part 2 Products

2.1 SPECIAL SUPPORTS

.1 Structural grade steel primed and painted after construction and before installation.

2.2 PIPING FOR PNEUMATIC CONTROL COMPONENTS

.1 Copper:

- .1 Tubing: shall be hard drawn copper, run parallel to the building lines.
- .2 Fittings: wrought copper solder type to ANSI/ASME B16.22, and 95.5 antimonial tin solder. At instruments use compression fittings.
- .3 At panels and junction boxes where there is a transition from plastic to copper use bulkhead fittings.

.2 Plastic:

- .1 Flame retardant, FR rated, black PVC with minimum burst strength 1.3 MPa at 23 degrees Celsius installed in conduit or tray.
- .2 Fittings: compression or barbed type as required.

.3 Use copper for all control air lines:

- .1 Where lines are subject to damage or temperatures in excess of 93°C (200°F).
- .2 Where lines are run adjacent to heating pipes passing through a common sleeve, or where not readily accessible.
- .3 Where life support or warning systems are to be controlled including VAV box control and air system dampers.
- .4 Where control air is supplied to fire and smoke dampers.
- .5 Where lines are run exposed in mechanical rooms, electrical rooms, etc.

2.3 WIRING

.1 As per requirements of Division 26.

.2 For 40V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Color code to CSA 22.1, minimum `12 AWG.

.3 For wiring under 40 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring in conduit.

.4 Sizes:

  .1 120V Power supply: to match or exceed breaker, size #12 AWG minimum.

  .2 Wiring for safeties/interlocks for starters, motor control centers, to be #12 AWG minimum.

  .3 Field wiring to digital device: #18 AWG or as required by sensors, transducers, etc. stranded twisted pair.

  .4 Analog input and output: shielded #20 minimum stranded twisted pair. Wiring must be continuous without joints.

  .5 More than 4 conductors in a cable: #22 minimum solid copper.

.5 Terminations:

  .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.4 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.

.3 Junction and pull boxes: welded steel.

  .1 Surface mounting cast FS: screw-on flat covers.

  .2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:

  .1 Bushings and connectors: with nylon insulated throats.

  .2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:

  .1 Couplings and fittings: threaded type steel.

  .2 Double locknuts and insulated bushings: use on sheet metal boxes.

  .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

2.5 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:

.1 50 mm diameter and smaller: one-hole steel straps.

.2 Larger than 50 mm diameter: two-hole steel straps.

.3 Suspended support systems:

.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.

.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 PNEUMATIC CONTROL DEVICES

.1 General:

.1 Install tubing in accessible concealed locations, straight, parallel and close to building structure with required grades for drainage and venting.

.2 Install drip legs and drains at low points.

.3 Tubing to be free from surface damage.

.4 Tubing NOT to pass through or touch unheated ducts or enclosures.

.5 Do not cover pneumatic tubing with insulation.

.6 Test tubing, check joints after connection to system.

.2 Copper tubing:

.1 Not to come into contact with dissimilar metal. Use non-metallic stand-offs on air handling systems.

.2 Install dielectric couplings where dissimilar metals are connected.

.3 Plastic tubing:

.1 Inaccessible locations: install plastic tubing in conduit.

.2 Inside panels: install in tube trays or racks, or clip individually to back of panel.

.3 Multiple tube bundles: install in tube trays, conduit or armored flexible cable.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

  .1 Division 26, this specification.

  .2 CSA 22.1 Canadian Electrical Code.

  .3 ANSI/NFPA 70.

  .4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage [above 70 V] contacts and mark to prevent accidental injury.

.3 Conform to manufacturer's recommendations for storage, handling and installation.

.4 Check factory connections and joints. Tighten where necessary to ensure continuity.

.5 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.6 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.7 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.8 Install conduits, and sleeves prior to pouring of concrete.

.9 Holes through exterior wall and roofs: flash and make weatherproof.

.10 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.11 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 CONDUIT SYSTEM

.1 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.2 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise

.3 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.4 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.5 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.6 Limit conduit length between pull boxes to less than 30 m.

.7 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.8 Fastenings and supports for conduits, cables, and equipment:

  .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

  .2 Provide adequate support for raceways and cables, sloped vertically to equipment.

  .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Consultant.

.9 Install polypropylene fish cord in empty conduits for future use.

.10 Where conduits become blocked, remove and replace blocked sections.

.11 Pass conduits through structural members only after receipt of Consultant's written approval.

.12 Conduits may be run in flanged portion of structural steel.

.13 Group conduits wherever possible on suspended or surface channels.

.14 Pull boxes:

  .1 Install in inconspicuous but accessible locations.

  .2 Support boxes independently of connecting conduits.

  .3 Fill boxes with paper or foam to prevent entry of construction material.

  .4 Provide correct size of openings. Reducing washers not permitted.

  .5 Mark location of pull boxes on record drawings.

  .6 Identify AC power junction boxes, by panel and circuit breaker.

.15 Install terminal blocks or strips in cabinets.

.16 Install bonding conductor for 120 volt and above in conduit.

3.5 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:

  .1 Circuits are continuous, free from shorts, unspecified grounds.

  .2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Consultant with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.7 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.

.2 Give 14 days written notice of intention to test.

.3 Conduct in presence of Consultant and authority having jurisdiction.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Consultant in writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Consultant and authority having jurisdiction.

3.8 IDENTIFICATION

.1 Refer to Section 25 05 54 - EMCS: Identification.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Service Agreement

.2 Service Calls

.3 Preventive Maintenance

1.2 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit detailed preventative maintenance schedule for system components to the Consultant.

.3 Submit detailed inspection reports ***to*** Consultant.

.4 Submit dated, maintenance task lists ***to*** the Consultant and include the following sensor and output point detail, as proof of system verification:

- .1 Point name and location.
- .2 Device type and range.
- .3 Measured value.
- .4 System displayed value.
- .5 Calibration detail
- .6 Indication if adjustment required,
- .7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

- .1 Maintain records and logs of each maintenance task on site.
- .2 Organize cumulative records for each major component and for entire BMS chronologically.
- .3 Submit records to Consultant***,*** after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Consultant in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to BMS made during warranty period.

1.4 WARRANTY

.1 Include warranty provisions identified in the specifications.

.2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BMS system.

.3 Provide onsite service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.

.4 Perform preventive maintenance (PM) during the warranty period.

.5 In addition to warranty call backs provide two (2) service and calibration inspections of a minimum four (4) of hours duration each. These calls will be initiated by the Owner.

.6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.

.7 The BMS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.

.8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.5 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain BMS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

  .1 Initiate service calls when BMS is not functioning correctly.

  .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

  .3 Furnish the Consultant with telephone number where service personnel may be reached at any time.

  .4 Service personnel to be on site ready to service BMS after receiving request for service. within 2 hours.

  .5 Perform Work continuously until BMS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of BMS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Consultant

1.6 SERVICE CONTRACTS

.1 For any existing service contracts provide assistance to Consultant and Owner in preparation and implementation of modifications to cover the new equipment and updated data base.

1.7 SERVICE CALLS

.1 The contract shall guarantee a 24 hour response time to service calls. Service calls received before 12:00 P.M. Monday through Friday shall be responded to the same day.

.2 Service shall be available 24 hours per day seven days per week.

1.8 PREVENTIVE MAINTENANCE

.1 Preventive maintenance shall include a minimum of (2) site visits per year, of (3) days duration per visit.

.2 The PM tasks to be performed at each visit shall include at a minimum:

.1 Check in with the building operator at the beginning of each visit and record time and date you arrived on site.

.2 Review the system for CRITICAL, FOLLOW-UP and OFF-LINE status indications.

.3 Review the system for OVERRIDE, DISABLED and LOCKOUT points.

.4 Review the event log with the operator and inquire about operational problems.

.5 Review the system for OVERRIDE, DISABLED and LOCKOUT points.

.6 Perform corrective procedures as required to resolve problems identified in preceding reviews.

.7 Network Analysis

.1 Produce a network analysis report that summarizes the performance of the network since the last PM visit. The report should indicate the transmission rate, error rate and performance ratio for each node on the network. Investigate suspected communications or network throughput problems. Review report and investigation results with the Owner. A copy of this report is to be placed in the site service log.

.8 Remove excess dust from cabinet interiors, circuit boards and heat sink surfaces of SCU's, ASC's and all control cabinets.

.9 Inspect wiring for signs of corrosion, fraying or discoloration.

.10 Check DC voltage levels and battery voltage levels as applicable.

.11 Control Loops

.1 Check that the control loop is being controlled at the appropriate values.

.2 Change the setpoint and verify smooth transition and stable control at the new setpoint.

.3 Return setpoint to original value.

.4 Repeat for each control loop.

.3 Verify that controlled valves and dampers stoke fully in both directions, sealing tightly where appropriate.

.4 Verify the operation of critical control processes and points. Make adjustments where necessary.

.5 Verify the calibration of 10 % of all analog input and output devices on each visit. Make adjustments where required. Record in the service log all points checked and identify those found to be out of calibration. On subsequent site visits the calibration of 10% of all analog input and output devices shall be completed on points not previously checked.

.6 Install software updates that have been released since the last visit. Replace EPROMs and motherboards as required to implement the software updates.

.7 Record all maintenance activities in the site service log and inform the operator before leaving the site.

Part 2 Products

Not Applicable

Part 3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform a minimum of (2) two inspections per year during warranty period. Provide detailed written report to Owner and Consultant.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.4 Continue system debugging and optimization.

END OF SECTION

1 General

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The BMS contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 The control sequences are intended to replicate the existing sequences and add minor changes as required. The BMS contractor shall review and utilize the existing sequences to finalize the new overall sequences.

.3 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system

2 Products

Not Applicable

3 Execution

3.1 GENERAL

.1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 AIR SYSTEM SF-1 CONTROL (BLOCK 100, 300 SUPPLY)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Receiving and Library areas of Block 100 and the East Labs (Block 300).

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, a Heating Coil, a Cooling Coil, and a Humidifier. The Heating Coil is equipped with a Coil Circulation Pump.

.3 The exhaust air system consists of three sets of two exhaust fans each which operate in unison as a Lead/Lag pair. Each exhaust fan has an Exhaust Air Damper.

.4 All fans are equipped with Variable Speed Drives.

.5 The Lead / Lag designation of the EF-315/316 pair of Exhaust Fans will be automatically alternated by the BMS once per month (initially scheduled for Wednesday at 1015 hours).

.6 The Lead / Lag designation of the EF-149/150 pair of Exhaust Fans will be automatically alternated by the BMS once per month (initially scheduled for Wednesday at 1045 hours).

.7 The Lead / Lag designation of the EF-125/126 pair of Exhaust Fans will be automatically alternated by the BMS once per month (initially scheduled for Wednesday at 1115hours).

.2 On shutdown:

.1 The Exhaust Fans and Supply Fans will be shut down.

.2 The Outdoor Air Dampers and Exhaust Air Dampers will be fully closed.

.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.

.4 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil

.5 The Humidifier Valve will be commanded to close flow to the Humidifier.

.3 STEADY STATE OPERATION

.1 Exhaust Fans EF-315/316 Control

.1 The speed of the Exhaust Fan will be modulated to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -475 Pa).
.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100Pa.

.2 Exhaust Fans EF-149/150 Control

.1 The speed of the Exhaust Fan will be modulated to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -475 Pa) in the Receiving area of Block 100.
.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.3 Exhaust Fans EF-125/126 Control

.1 The speed of the Exhaust Fans will be modulated to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -475 Pa) in the Library area of Block 100.
.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.4 Supply Fan SF-1 Speed Control

.1 The speed of the Supply Fan will be modulated to maintain the Supply Duct Static Pressure set point (adjustable, initially set at 350Pa), measured as the minimum of the Block 100 and the Block 300 Supply Air Ducts.
.2 At all times the speed of the Supply Fan will be overridden to limit the Fan

Outlet Discharge Pressure to a maximum of 600 Pa.

.5 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.2 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.3 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.6 Humidity Control

.1 The Humidifier Valve control loop will be enabled by a time of day schedule and fan operation has been proven.

.2 The Humidifier Valve will be modulated to maintain the Exhaust Air Humidity set point. The Humidity is measured as the average of the Exhaust Air Humidity to EF-315/316, the Exhaust Air Humidity to EF-149/150, and the Exhaust Air Humidity to EF-125/126.

.3 Exhaust Air Humidity set point is reset by the Outdoor Air Temperature according to the following schedule:

Outdoor Air Temp	Exhaust Humidity Setpoint
5.0 DegC	45.0 %RH
-34.0 DegC	30.0 %RH

.4 The operation of the Humidifier Valve is overridden to limit the Discharge Air Humidity to a maximum of 70 %RH.

.4 EMERGENCY MODES

.1 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.2 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.3 If the Fire Override Switch (located at the Fire Alarm Panel) is activated, the hardwired Fire Alarm Shutdown contacts will be overridden and the system will be re-started as described above.

.4 When the Fire Override Switch is activated an audible alarm will be activated (2 second pulse every 5 seconds) until the Fire Override Switch is de-activated. Note that this will occur whether or not a Fire Alarm is detected,

.5 The Transfer Air Dampers associated with Supply Air System SF-3 will be switched manually by an operator command to allow SF-3 to maintain the SF-1 supply air duct pressure if any of the following occurs (refer also to the Supply Air System SF-3 sequence for further details):

.1 Supply Fan SF-1 status does not match command (10 second time delay).
.2 Supply Fan SF-1 Fan VSD Alarm status is on.
.3 Supply Fan SF-1 Outdoor Air Damper status does not match command (60 second time delay).
.4 Supply Fan SF-1 Low Temperature Sensor has been activated.
.5 Supply Fan SF-1 is commanded off and the Fire Alarm is not active.

.6 If an alarm causes the Supply Air System SF-1 to shutdown (any alarm except the Dirty Filter Alarm or a Fire Alarm), the Transfer Air Dampers associated with Supply Air System SF-3 will be switched to allow SF-3 to maintain the SF-1 supply air duct pressure. Refer also to the Supply Air System SF-3 sequence for further details.

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Supply Fan VSD status does not match command (10 second time delay)
.2 Supply Fan VSD Alarm status = ON
.3 Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)
.5 Low Temperature Sensor Alarm status = ON

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.2 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.3 Heating Coil Flow Switch Status does not match command (10 second delay)
.4 Exhaust Fan VSD status does not match command (10 second time delay)
.5 Exhaust Fan VSD Alarm status = ON

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.5 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

.6 All fan alarms are latching.

3.3 AIR SYSTEM SF-2 CONTROL (ADMINISTRATION)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Administration and Library areas of Block 100.

.2 The supply air system consists of a mixed air system with Outdoor Air, Return Air, and Exhaust Air Dampers, a Heating Coil and a Cooling Coil, and a Humidifier. The Heating Coil is equipped with a Coil Circulation Pump.

.3 Both the Supply and Return Fans are equipped with Variable Speed Drives.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 When the Master Command for Block 100/300 is commanded to ON, the Air System will be commanded to start.

.2 The Return Fan will be commanded to start and the Return Fan VSD will be commanded to operate at its minimum speed (initially set at 25%). When the operation of the fan is stable, the respective fan control loops will be enabled to operate.

.3 When the status of the Return Fan is on, the Supply Fan will be commanded to start and the Supply Fan VSD will be commanded to operate at its minimum speed (initially set at 25%). When the operation of the fan is stable, the Minimum Outdoor Air Damper will be fully opened and the fan control loops will be enabled to operate.

.4 On shutdown:

.1 The Return Fan and the Supply Fan will be shut down.
.2 The Outdoor Air Dampers and Exhaust Air Dampers will be fully closed and the Return Air Damper will be fully opened.
.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
.4 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil.
.5 The Humidifier Valve will be commanded to close flow to the Humidifier.
.6 When the Outdoor Air Temperature is below the Heating Lockout set

point, the Coil Circulation Pump will be started and the Heating Coil Valve will be modulated to maintain the Heating Coil Discharge Air Temperature set point.

.3 STEADY STATE OPERATION

.1 Supply Fan SF-2 Speed Control

.1 The speed of the Supply Fan will be modulated to maintain the Supply Duct Static Pressure set point (adjustable, initially set at 400 Pa), measured as the minimum of the Block 100 and the Block 300 Supply Air Ducts.

.2 At all times the speed of the Supply Fan will be overridden to limit the Fan Outlet Discharge Pressure to a maximum of 800Pa.

.2 Return Fan SF-1 Speed Control

.1 The speed of the Return Fan will be modulated to maintain the Return Air Flow set point. The Return Air Flow set point is calculated as the measured Supply Air Flow less a fixed differential (adjustable, initially set at 400 L/sec).

.3 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.2 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.3 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.4 Humidity Control

.1 The Humidifier Valve control loop will be enabled on a time of day schedule.

.2 The Humidifier Valve will be modulated to maintain the Return Air Humidity set point. The Return Air Humidity set point is reset by the Outdoor Air Temperature according to the following schedule:

Outdoor Air Temp	Return Humidity Setpoint
5.0 DegC	40.0 %RH
-34.0 DegC	30.0 %RH

.3 The operation of the Humidifier Valve is overridden to limit the Discharge Air Humidity to a maximum of 70 %RH.

.4 EMERGENCY MODES

.1 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.2 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.3 If the Fire Override Switch (located at the Fire Alarm Panel) is activated, the hardwired Fire Alarm Shutdown contacts will be overridden and the system will be re-started as described above.

.4 When the Fire Override Switch is activated an audible alarm will be activated (2 second pulse every 5 seconds) until the Fire Override Switch is de-activated. Note that this will occur whether or not a Fire Alarm is detected.

.5 The Transfer Air Dampers associated with Supply Air System SF-3 will be manually switched by the operator to allow SF-3 to maintain the SF-2 supply air duct pressure if any of the following occurs (refer also to the Supply Air System SF-3 sequence for further details):

.6 Supply Fan SF-2 status does not match command (10 second time delay).
.7 Supply Fan SF-2 Fan VSD Alarm status is on.
.8 Supply Fan SF-2 Outdoor Air Damper status does not match command (60 second time delay).
.9 Supply Fan SF-2 Low Temperature Sensor has been activated.
.10 Supply Fan SF-2 is commanded off and the Fire Alarm is not active.

.6 If an alarm causes the Supply Air System SF-2 to shutdown (any alarm except the Dirty Filter Alarm or a Fire Alarm), the Transfer Air Dampers associated with Supply Air System SF-3 will be manually switched by the operator to allow SF-3 to maintain the SF-2 supply air duct pressure. Refer also to the Supply Air System SF-3 sequence for further details.

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Low Temperature Sensor Alarm status = ON
.2 Fire Alarm Status

.2 LEVEL 2 ALARMS

.1 Fan VSD status does not match command (10 second time delay)
.2 Fan VSD Alarm status = ON

.3 Pump Status does not match command (10 second delay)

.4 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)

.5 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)

.6 Heating Coil Flow Switch Status does not match command (10 second delay)

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

.5 All fan alarms are latching.

3.4 AIR SYSTEM SF-3 CONTROL (BLOCK 200 LAB SUPPLY)

.1 GENERAL

.1 This control sequence applies to the Block 200 Labs Air System.

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, a Heating, a Cooling Coil, and a Humidifier. The Heating Coil is equipped with a Coil Circulation Pump.

.3 This supply air system also includes a pair of Transfer Dampers to control the flow of air to other blocks in the event of emergency or air system failure. This supply air system will control airflow between one of the following:

.1 Between Block 200 and Blocks 100 and 300. In case of failure of Block 100 and Block 300 Labs Air system (SF-1); this Air System will be used to supply air to Block 100 and Block 300

.2 Between Block 200 and Administration Block. In case of failure of Administration Block Labs Air Systems (SF-2); this Air System will be used to supply air to Administration Block.

.4 The exhaust air system consists of two sets of two exhaust fans each which operate in unison as a Lead/Lag pair. Each exhaust fan has an Exhaust Air Damper.

.5 All fans are equipped with Variable Speed Drives.

.6 The Lead / Lag designation of the EF-226/227 pair of Exhaust Fans will be automatically alternated by the BMS once per week (initially scheduled for Wednesday at 1015 hours).

.7 The Lead / Lag designation of the EF-228/229 pair of Exhaust Fans will be automatically alternated by the BMS once per week (initially scheduled for Wednesday at 1045 hours).

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 When the Master Command for Block 200 is commanded to ON, the Air System will be commanded to start.

.1 Exhaust fan dampers will only open when status is received from its associated exhaust fan
.2 On start up both fans are commanded, after status is proven the lag exhaust fan is shut down, the exhaust fans will run in a lead lag operation, should the lead fan fail the lag fan will be started.
.3 When Supply fan 1 is off the Exhaust fan differential set point is set back to 100 pa to keep the rooms from becoming too negative.
.4 Supply fan 1 will only be enabled start when it receives at least one status from each pair of exhaust fans.

.2 The Transfer Air Dampers associated with Supply Air System SF-3 will be switched manually by the operator to allow SF-3 to maintain the SF-1 or SF-2 supply air duct pressure if any of the following occurs. Air system SF-3 will operate in place of the respective unit that is shutdown:

.1 Supply Fan SF-1 or SF-2 status does not match command (10 second time delay).
.2 Supply Fan SF-1 or SF-2 Fan VSD Alarm status is on.
.3 Supply Fan SF-1 or SF-2 Outdoor Air Damper status does not match command (60 second time delay).
.4 Supply Fan SF-1 or SF-2 Low Temperature Sensor has been activated.
.5 Supply Fan SF-1 or SF-2 is commanded off and the Fire Alarm is not active.

.3 If an alarm causes the Supply Air System SF-1 or SF-2 to shutdown (any alarm except the Dirty Filter Alarm or a Fire Alarm), the Transfer Air Dampers associated with Supply Air System SF-3 will be switched manually by the operator to allow SF-3 to maintain the SF-1 or SF-2 supply air duct pressure.

.4 When the status of at least one Exhaust Fan of each pair is on (dictated by the air system served), the Outdoor Air Damper of Supply Fan SF-3 will be fully opened. When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-3 will be started and commanded to operate at its minimum speed (initially set at 25%). When the operation of Supply Fan SF- 3 is stable, the fan control loops will be enabled to operate.

.5 On shutdown:

.1 The Exhaust Fans and Supply Fans will be shut down.
.2 The Outdoor Air Dampers and Exhaust Air Dampers will be fully closed.

.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.

.4 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil.

.5 The Humidifier Valve will be commanded to close flow to the Humidifier.

.6 The Transfer Dampers will modulate back into their original positions.

.3 STEADY STATE OPERATION

.1 Exhaust Fans EF-226/227 Control

.1 The speed of the Exhaust Fans will be modulated to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -475 Pa).

.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.2 Exhaust Fans EF-228/229 Control

.1 The speed of the Exhaust Fans will be modulated to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -475Pa).

.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.3 Supply Fan SF-3 Speed Control

.1 The speed of the Supply Fan will be modulated to maintain the Supply Duct Static Pressure set point (adjustable, initially set at 350 Pa).

.2 At all times the speed of the Supply Fan will be overridden to limit the Fan Outlet Discharge Pressure to a maximum of 800 Pa.

.4 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.2 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.3 When the Preheat Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Preheat Coil Valve is commanded to less than 2%. The minimum run time of the pump is 300 seconds (adjustable).). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.5 Humidity Control

.1 The Humidifier Valve control loop will be enabled by a time of day schedule.

.2 The Humidifier Valve will be modulated to maintain the Exhaust Air Humidity set point. The Humidity is measured as the average of the Exhaust Air Humidity to EF-226/227 and the Exhaust Air Humidity to EF-228/229.

.3 Exhaust Air Humidity set point is reset by the Outdoor Air Temperature according to the following schedule:

.4 Outdoor Air Temp Exhaust Humidity Setpoint

.5 5.0 DegC 45.0 %RH

.6 -34.0 DegC 30.0 %RH

.7 The operation of the Humidifier Valve is overridden to limit the Discharge Air Humidity to a maximum of 85 %RH.

.4 AIR HANDLING UNIT SF-1 BACKUP OPERATION

.1 When Air Handling Unit SF-3 provides backup to air system SF-1, the supply fan, heating coil, cooling coil, humidification, and dampers of air system SF-3 will follow the sequence of operation of the respective unit being backed up.

.2 When Air Handling Unit SF-3 provides backup to air system SF-1, the associated exhaust fans and dampers will follow the sequence of operations of the respective system being backed up.

.5 AIR HANDLING UNIT SF-2 BACKUP OPERATION

.1 When Air Handling Unit SF-3 provides backup to air system SF-2, the supply fan, heating coil, cooling coil, humidification, and dampers of air system SF-3 will follow the sequence of operation of the respective unit being backed up.

.2 When Air Handling Unit SF-3 provides backup to air system SF-2, the associated return fan will follow the sequence of operation of the respective unit being backed up. The exhaust air dampers will open and return air dampers will remain closed.

.6 EMERGENCY MODES

.1 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.2 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.3 If the Fire Override Switch (located at the Fire Alarm Panel) is activated, the hardwired Fire Alarm Shutdown contacts will be overridden and the system will be re-started as described above.

.4 When the Fire Override Switch is activated an audible alarm will be activated (2 second pulse every 5 seconds) until the Fire Override Switch is de-activated. Note that this will occur whether or not a Fire Alarm is detected,

.7 ALARMS

.1 LEVEL 1 ALARMS

.1 Supply Fan VSD status does not match command (10 second time delay)
.2 Supply Fan VSD Alarm status = ON
.3 Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)
.5 Low Temperature Sensor Alarm status = ON
.6 Fire Alarm status

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.2 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.3 Heating Coil Flow Switch Status does not match command (10 second delay)
.4 Exhaust Fan VSD status does not match command (10 second time delay)
.5 Exhaust Fan VSD Alarm status = ON

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

.5 All fan alarms are latching.

3.5 AIR SYSTEM SF-4 CONTROL (BLOCK 400 LAB SUPPLY)

.1 GENERAL

.1 This control sequence applies to the Block 400 Labs Air System.

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, a Heating Coil, a Cooling Coil, and a Humidifier. The Heating Coil is equipped with a Coil Circulation Pump.

.3 The exhaust air system consists of two sets of two exhaust fans each which operate in unison as a Lead/Lag pair. The EF-433/434 pair of exhaust fans each has an Exhaust Air Damper. The EF-435/436 pair of exhaust fans each has an Exhaust Air Damper and an Isolation Damper and will work in unison.

.4 All fans are equipped with Variable Speed Drives.

.5 The Lead / Lag designation of the EF-433/434 pair of Exhaust Fans will be automatically alternated by the BMS once per week (initially scheduled for Wednesday at 1015 hours).

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 When the Master Command for Block 400 is commanded to ON, the Air System will be commanded to start.

.1 Exhaust fan dampers will only open when status is received from its associated exhaust fan
.2 On start up both fans are commanded, after status is proven the lag exhaust fan is shut down, the exhaust fans will run in a lead lag operation, should the lead fan fail the lag fan will be started.
.3 When Supply fan 1 is off the Exhaust fan differential set point is set back to 100 pa to keep the rooms from becoming too negative.
.4 Supply fan 1 will only be enabled start when it receives at least one status from each pair of exhaust fans.

.2 When the status of at least one Exhaust Fan of each pair is on, the Outdoor Air Damper of Supply Fan SF-4 will be fully opened. When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-4 will be started and commanded to operate at its minimum speed (initially set at 25%). When the operation of Supply Fan SF- 4 is stable, the fan control loops will be enabled to operate.

.3 On Shutdown

.1 The Exhaust Fans and Supply Fans will be shut down.
.2 The Outdoor Air Dampers, Exhaust Air Dampers, and Exhaust Fan Inlet Dampers will be fully closed.
.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
.4 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil.
.5 The Humidifier Valve will be commanded to close flow to the Humidifier.

.3 STEADY STATE OPERATION

.1 Exhaust Fans EF-433/434 Control

.1 The speed of the Exhaust Fans will be modulated to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -475 Pa).
.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.2 Exhaust Fans EF-435/436 Control

.1 The speed of the Exhaust Fans will be modulated in unison to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -500 Pa).

.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.3 Supply Fan SF-4 Speed Control

.1 The speed of the Supply Fan will be modulated to maintain the Supply Duct Static Pressure set point (adjustable, initially set at 400 Pa).

.2 At all times the speed of the Supply Fan will be overridden to limit the Fan Outlet Discharge Pressure to a maximum of 800 Pa.

.4 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.2 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.3 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.5 Humidity Control

.1 The Humidifier Valve control loop will be enabled by a time of day schedule.

.2 The Humidifier Valve will be modulated to maintain the Exhaust Air Humidity set point. The Humidity is measured as the average of the Exhaust Air Humidity to EF-433/434 and the Exhaust Air Humidity to EF-435/436.

.3 Exhaust Air Humidity set point is reset by the Outdoor Air Temperature according to the following schedule:

.4

Outdoor Air Temp	Exhaust Humidity Setpoint
5.0 DegC	45.0 %RH
-34.0 DegC	30.0 %RH

.5 The operation of the Humidifier Valve is overridden to limit the Discharge Air Humidity to a maximum of 70 %RH.

.4 EMERGENCY MODES

.1 The Transfer Air Dampers associated with Supply Air System SF-6 will be switched manually by the operator to allow SF-6 to maintain the SF-4 supply air duct pressure if any of the following occurs (refer also to the Supply Air System SF-6 sequence for further details):

.6 Supply Fan SF-4 status does not match command (10 second time delay).
.7 Supply Fan SF-4 Fan VSD Alarm status is on.
.8 Supply Fan SF-4 Outdoor Air Damper status does not match command (60 second time delay).
.9 Supply Fan SF-4 Low Temperature Sensor has been activated.
.10 Supply Fan SF-4 is commanded off and the Fire Alarm is not active.

.2 If an alarm causes the Supply Air System SF-4 to shutdown (any alarm except the Dirty Filter Alarm or a Fire Alarm), the Transfer Air Dampers associated with Supply Air System SF-6 will be switched manually by the operator to allow SF-6 to maintain the SF-4 supply air duct pressure. Refer also to the Supply Air System SF-6 sequence for further details.

.3 The Level 3 Lab Systems will be signaled if any of the following occurs (refer also to the Level 3 Lab sequences for further details):

.1 Exhaust Fan EF-435 or EF-436 status does not match command (10 second time delay).
.2 Exhaust Fan EF-435 or EF-436 Fan VSD Alarm status is on.
.3 Exhaust Fan EF-435 or EF-436 is commanded off and the Fire Alarm is not active.

.4 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.5 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.6 If the Fire Override Switch (located at the Fire Alarm Panel) is activated, the hardwired Fire Alarm Shutdown contacts will be overridden and the system will be re-started as described above.

.7 When the Fire Override Switch is activated an audible alarm will be activated (2 second pulse every 5 seconds) until the Fire Override Switch is de-activated. Note that this will occur whether or not a Fire Alarm is detected,

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Supply Fan VSD status does not match command (10 second time delay)

.2 Supply Fan VSD Alarm status = ON
.3 Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)
.5 Low Temperature Sensor Alarm status = ON
.6 Fire Alarm status
.7 Heating Coil Flow Switch Status does not match command (10 second delay)
.8 Exhaust Fan 435/436 VSD status does not match command (10 second time delay)
.9 Exhaust Fan 435/436 VSD Alarm status = ON
.10 Exhaust Air Humidity (435/436) is more than 5.0 %RH (adjustable) from set point (60 second time delay)

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.2 Exhaust Air Humidity (433/434) is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.3 Exhaust Fan 433/434 VSD status does not match command (10 second time delay)
.4 Exhaust Fan 433/434 VSD Alarm status = ON

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.5 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

.6 ALARMS

.1 An alarm will be generated for any of the following conditions:

.1 Fan status does not match command (10 second time delay).
.2 Fan VSD Alarm status is on.
.3 Outdoor Air Damper status does not match command (60 second time delay).
.4 Pump status does not match command (10 second time delay).
.5 Supply Air Temperature is less than 16.0° C (adjustable) (60 second time delay).
.6 Low Temperature Sensor has been activated.
.7 High Filter Differential Pressure Switch has been activated.
.8 Fire Alarm is detected.

.2 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

3.6 AIR SYSTEM SF-5 CONTROL (ATRIUM)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Atrium area of Block 100.

.2 The supply air system consists of a mixed air system with a constant volume Supply Fan and two constant volume Return Fans. In addition, there is an Outdoor Air Damper, a Heating Coil and a Cooling Coil, and a Humidifier. The Heating Coil is equipped with a Coil Circulation Pump. Each Return Fan has a Return Air Damper and an Exhaust Air Damper. There are also two Reheat Coils, one serving the West side of the Atrium and the other serving the East side of the Atrium.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will operate on a programmed time schedule (initially set to operate continuously) as entered by the System Operator.

.2 The Return Fans will be commanded to start. When the status of either Return Fan is on, the Supply Fan will be commanded to start. When the status of the Supply Fan is on, the Minimum Outdoor Air Damper will be fully opened and the system control loops will be enabled to operate.

.3 On shutdown:

.1 The Return Fans and the Supply Fan will be shut down.
.2 The Outdoor Air Dampers and Exhaust Air Dampers will be fully closed and the Return Air Dampers will be fully opened.
.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
.4 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil.
.5 The Humidifier Valve will be commanded to close flow to the Humidifier.
.6 The Reheat Coil Valves will be commanded to close flow to the Reheat Coils.
.7 When the Outdoor Air Temperature is below the Heating Lockout set point, the Coil Circulation Pump will be started and the Heating Coil Valve will be modulated to maintain the Heating Coil Discharge Air Temperature set point.

.3 STEADY STATE OPERATION

.1 Damper Control

.1 On initial startup the dampers will remain in their fail-safe positions. The position of the dampers will be adjusted according to one of the following situations.

.2 When the Outdoor Air Temperature is higher than the space temperature, the dampers will be controlled according to the following.

- If the OAT > Upper Atrium Return Air Temperature then:
  The Return Air Damper and Exhaust Air Damper of the Upper Atrium Return Fan RF-101 will be commanded to the full Return Air position.
- If the OAT > Lower Atrium Return Air Temperature then:
  The Return Air Damper and Exhaust Air Damper of the Lower Atrium Return Fan RF-102 will be commanded to the full Return Air position.

.3 When the OAT > MAT Set Point AND the OAT < Upper Atrium Return Air Temperature, the dampers will be controlled according to the following.

- The Return Air Damper and Exhaust Air Damper of the Upper Atrium Return Fan RF-101 will be commanded to the full Exhaust Air position and
- The Outdoor Air Damper will be commanded to the 75% Outdoor Air position.

.4 When the OAT > MAT Set Point AND the OAT < Lower Atrium Return Air Temperature, the dampers will be controlled according to the following.

- The Return Air Damper and Exhaust Air Damper of the Lower Atrium Return Fan RF-102 will be commanded to the full Exhaust Air position and
- The Outdoor Air Damper will be commanded to the 25% Outdoor Air position.

.5 When the OAT < MAT Set Point, the dampers will be controlled according to the following.

- The Return Air Damper and Exhaust Air Damper of the Upper Atrium Return Fan RF-101 and the Return Air Damper and Exhaust Air Damper of the Upper Atrium Return Fan RF-102 and the Outdoor Air Damper will be modulated to maintain the desired Mixed Air Temperature set point (adjustable, initially set at 13.0 DegC).

.2 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint.

.2 The Supply Air Temperature set point is reset by the Lower Atrium Room Temperature according to the following schedule:

Lower Atrium Temp	Supply Air Temp Setpoint
19.0 DegC	25.0 DegC
24.0 DegC	15.0 DegC

.3 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2%. The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg

.4 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.5 The West and East Reheat Coil Valves will be modulated to maintain the Upper Atrium Room Temperature set point (adjustable, initially set at 22.5 DegC).

.3 Humidity Control

.1 The Humidifier Valve control loop will be enabled by a time of day schedule.

.2 The Humidifier Valve will be modulated to maintain the Upper Atrium Humidity set point. The Upper Atrium Humidity set point is reset by the Outdoor Air Temperature according to the following schedule:

Outdoor Air Temp Upper	Atrium Humidity Setpoint
5.0 DegC	45.0 %RH
-34.0 DegC	30.0 %RH

.3 The operation of the Humidifier Valve is overridden to limit the Discharge Air Humidity to a maximum of 70 %RH.

.4 EMERGENCY MODES

.1 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.2 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc.)

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Fan status does not match command (10 second time delay)
.2 Pump Status does not match command (10 second delay)
.3 Low Temperature Sensor Alarm status = ON
.4 Fire Alarm is detected.

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.2 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.3 Heating Coil Flow Switch Status does not match command (10 second delay)
.4 Upper Atrium Temperature is less than 17.0° C (adjustable) (180 second time delay).

.5 Lower Atrium Temperature is less than 15.0° C (adjustable) (180 second time delay).

.6 Lower Atrium Temperature is greater than 26.0° C (adjustable) (180 second time delay).

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

.5 All equipment alarms are latching.

3.7 AIR SYSTEM SF-6 CONTROL (INTERSTITIAL SPACE VENTILATION)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Interstitial, Fan Loft and Crawlspace areas.

.2 The supply air system consists of a 100% outdoor system with a variable volume Supply Fan and nine Exhaust Fans distributed throughout the facility. The Supply Air System has an Outdoor Air Damper, a Heating Coil, a Cooling coil, and a Humidifier. The Heating Coil is equipped with a Coil Circulation Pump. Each Exhaust Fan has an Exhaust Air Damper.

.3 This supply air system also includes a pair of transfer dampers to control the flow of air to other blocks in the event of emergency or air system failure. This supply air system will control airflow between one of the following:

.1 Between the Interstitial, Fan Loft, Crawlspace areas and Block 400. In case of failure of Block 400 Labs Air System (SF- 4); this Air System will be used to supply air to Block 400.

.2 Between the Interstitial, Fan Loft, Crawlspace areas and Block 200. In case of failure of Block 200 Labs Air System (SF-3); this Air System will be used to supply air to Block 200.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will operate on a programmed time schedule (initially set to operate continuously) as entered by the System Operator. Dampers leading into the interstitial and crawl space will be alternated once a day along with their associated exhaust fans to provide fresh air into each space. The veins on the supply damper will be commanded according to the following schedule

Crawl space – 50%
Interstitial – 75%
Both areas – 100%

.2 The Exhaust Fans will be commanded to start. When the status of any Exhaust Fan is on, the associated Exhaust Air Damper will be fully opened.

.3 When the status of any Exhaust Fan is on, the Outdoor Air Damper of Supply Fan SF-6 will be fully opened. When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-6 will be started.

.4 When the status of Supply Fan SF-6 is on, the control loops will be enabled to operate.

.5 The Transfer Air Dampers associated with Supply Air System SF-6 will be switched manually by the operator to allow SF-6 to maintain the SF-3 or SF-4 supply air duct pressure if any of the following occurs. Air system SF-6 will operate in place of the respective unit that is shutdown:

 .1 Supply Fan SF-3 or SF-4 status does not match command (10 second time delay).
 .2 Supply Fan SF-3 or SF-4Fan VSD Alarm status is on.
 .3 Supply Fan SF-3 or SF-4Outdoor Air Damper status does not match command (60 second time delay).
 .4 Supply Fan SF-3 or SF-4Low Temperature Sensor has been activated.
 .5 Supply Fan SF-3 or SF-4is commanded off and the Fire Alarm is not active.

.6 If an alarm causes the Supply Air System SF-3 or SF-4 to shutdown (any alarm except the Dirty Filter Alarm or a Fire Alarm), the Transfer Air Dampers associated with Supply Air System SF-6 will be switched manually by the operator to allow SF-6 to maintain the SF-3 or SF-4 supply air duct pressure.

.7 When the status of at least one Exhaust Fan of each pair is on (dictated by the air system served), the Outdoor Air Damper of Supply Fan SF-6 will be fully opened. When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-6 will be started and commanded to operate at its minimum speed (initially set at 25%). When the operation of Supply Fan SF- 6 is stable, the fan control loops will be enabled to operate.

.8 On shutdown:

 .1 The Exhaust Fans and the Supply Fan will be shut down.
 .2 The Outdoor Air Dampers and Exhaust Air Dampers will be fully closed.
 .3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
 .4 When the Outdoor Air Temperature is below the Heating Lockout set point, the Coil Circulation Pump will be started and the Heating Coil Valve will be modulated to maintain the Heating Coil Discharge Air Temperature set point.
 .5 The Transfer Dampers will modulate back into their original position.

.3 STEADY STATE OPERATION

.1 Temperature Control

.1 The Heating Coil Valve and the Heat Recovery Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 15.0 DegC).
.2 The operation of the Heating Coil Valve will be overridden as necessary to limit the Heating Coil Discharge Air Temperature to a minimum set point (adjustable, initially set at 12.0 DegC).
.3 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). less than 2%. The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.2 Air Handling Unit SF-4 Backup Operation

.1 When Air Handling Unit SF-6 provides backup to air system SF-4, the supply fan, heating coil, cooling coil, humidification coil, and dampers of air system SF-6 will follow the sequence of operation of the respective unit being backed up.
.2 When Air Handling Unit SF-6 provides backup to air system SF-4, the associated exhaust fans and dampers will follow the sequence of operations of the respective system being backed up.

.3 Air Handling Unit SF-3 Backup Operation

.1 When Air Handling Unit SF-6 provides backup to air system SF-3, the supply fan, heating coil, cooling coil, humidification coil, and dampers of air system SF-6 will follow the sequence of operation of the respective unit being backed up.
.2 When Air Handling Unit SF-6 provides backup to air system SF-3, the associated exhaust fans and dampers will follow the sequence of operations of the respective system being backed up.

.4 EMERGENCY MODES

.1 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.2 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Low Temperature Sensor Alarm status = ON
.2 Fire Alarm Status

.2 LEVEL 2 ALARMS

.1 Fan VSD status does not match command (10 second time delay)
.2 Fan VSD Alarm status = ON
.3 Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)
.5 Supply Air Temperature is more than 2.0° C (adjustable) from setpoint (60 second time delay)
.6 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.7 Heating Coil Flow Switch Status does not match command (10 second delay)
.8 West Labs Fan Loft Temperature is above 28.0 DegC (adjustable) (180 second time delay).
.9 East Labs Fan Loft Temperature is above 28.0 DegC (adjustable) (180 second time delay).
.10 Library Fan Loft Temperature is above 28.0 DegC (adjustable) (180 second time delay).
.11 High Hazard Fan Loft Temperature is above 28.0 DegC (adjustable) (180 second time delay).

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.5 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

3.8 AIR SYSTEM SF-7 CONTROL (MECHANICAL BLOCK VENTILATION)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Mechanical Room.

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, an Emergency Supply Air Damper, a Heating Coil and a Cooling Coil. The Heating Coil is equipped with a Coil Circulation Pump.

.3 The Supply Fan is equipped with a Variable Speed Drive.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will be commanded to start if one of the following conditions is met:

.1 Mechanical Room Temperature is above 26.0 DegC (adjustable), or
.2 The status of any Boiler is on, or
.3 The System Operator issues a Manual Command.

.2 The Outdoor Air Damper of Supply Fan SF-7 will be fully opened. When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-7 will be started and commanded to operate at its minimum speed (initially set at 25%).

.3 When the status of Supply Fan SF-7 is stable, the control loops will be enabled to operate.

.4 On shutdown:

.1 The Supply Fan will be shut down.
.2 The Outdoor Air Damper will be fully closed.
.3 The Emergency Supply Air Damper will be fully opened.
.4 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
.5 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil.

.3 STEADY STATE OPERATION

.1 Supply Fan SF-7 Speed Control

.1 The speed of the Supply Fan will be modulated to maintain the Supply Air Flow set point, measured as the sum of the West and East Supply Air Ducts.
.2 The Supply Air Flow set point is reset according to the following schedule:

	Supply Air Flow Setpoint
High Space Temp	1,770 L/sec (25.0 %)
1 Boiler on	1,770 L/sec (25.0 %)
2 Boilers on	3,540 L/sec (50.0 %)
3 Boilers on	5,310 L/sec (75.0 %)
4+ Boilers on	7,079 L/sec (100.0 %)

.2 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.2 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg

.3 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.4 EMERGENCY MODES

.1 If any of the following conditions occurs, the Supply Fan will be shut down and the Emergency Supply Air Damper will be fully opened:

.1 The status of the Outdoor Air Damper indicates that the damper is closed for more than 60 seconds, or
.2 The measured Supply Air Volume is more than 300 L/sec (adjustable) below the current set point for more than 120 seconds (adjustable).
.3 The Local Mode Switch (EMCS or Emergency) is manually placed in the “Emergency” position.

.2 When the Emergency Mode has been activated, an alarm will be generated and the system will remain in the Emergency Mode for a minimum period of 10 minutes (adjustable). The Local Mode Switch must be manually returned to the “EMCS” position in order to allow the system to re-start normally.

.3 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.4 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Low Temperature Sensor Alarm status = ON
.2 Fire Alarm Status
.3 CO2 Level is greater than 1200 ppm (adjustable) (120 second time delay)

.2 LEVEL 2 ALARMS

.1 Fan VSD status does not match command (10 second time delay)
.2 Fan VSD Alarm status = ON
.3 Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)

.5 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.6 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.7 Heating Coil Flow Switch Status does not match command (10 second delay)

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.5 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

.6 ALARMS

.1 An alarm will be generated for any of the following conditions:

.1 Fan status does not match command (10 second time delay).
.2 Fan VSD Alarm status is on.
.3 Outdoor Air Damper status does not match command (60 second time delay).
.4 Pump status does not match command (10 second time delay).
.5 Supply Air Temperature is less than 16.0° C (adjustable) (60 second time delay).
.6 Supply Air Flow is more than 300 L/sec (adjustable) below set point (120 second time delay).
.7 Low Temperature Sensor has been activated.
.8 High Filter Differential Pressure Switch has been activated.
.9 Fire Alarm is detected.

.2 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

3.9 AIR SYSTEM SF-8 CONTROL (BASEMENT MECHANICAL ROOM VENTILATION)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Basement Mechanical Room.

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, a Heating Coil, a Cooling Coil. The Heating Coil is equipped with a Coil Circulation Pump.

.3 There are also two Exhaust Fans (EF-430 and EF-431) located in the Fan Loft, each with an Exhaust Air Damper.

.4 The Duty / Standby designation of the Exhaust Fans will be automatically alternated by the BMS once per month.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will run continuously.

.2 When the system is started, the Lead Exhaust Fan will be commanded to start. When the status of the Exhaust Fan is on, the associated Exhaust Air Damper will be fully opened.

.3 When the status of any Exhaust Fan is on, the Outdoor Air Damper of Supply Fan SF-8 will be fully opened. When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-8 will be started.

.4 When the status of Supply Fan SF-8 is on, the control loops will be enabled to operate.

.5 On shutdown:

.1 The Supply Fan will be shut down.
.2 The Outdoor Air Damper will be fully closed.
.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
.4 The Cooling Coil Valve will be commanded to close flow to the Cooling Coil.
.5 When the Outdoor Air Temperature is below the Heating Lockout set point, the Coil Circulation Pump will be started and the Heating Coil Valve will be modulated to maintain the Heating Coil Discharge Air Temperature set point.

.3 STEADY STATE OPERATION

.1 Temperature Control

.1 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).
.2 The operation of the Heating Coil Valve will be overridden as necessary to limit the Heating Coil Discharge Air Temperature to a minimum set point (adjustable, initially set at 12.0 DegC).
.3 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all

temperatures below 5 deg c.

.4 When the Outdoor Air Temperature is below the Cooling Lockout set point (adjustable, initially set at 13.0 DegC), the Cooling Coil Valve will be fully closed.

.4 EMERGENCY MODES

.1 If the Duty Exhaust Fan is commanded on and the status does not match the command after a time delay, an alarm will be generated, the Duty Exhaust Fan will be shut down, the associated Exhaust Air Damper will be fully opened and the Standby Exhaust Fan will be started.

.2 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.3 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Supply Fan status does not match command (10 second time delay)
.2 Damper status does not match command (60 second time delay)
.3 Pump Status does not match command (10 second delay)
.4 Low Temperature Sensor Alarm status = ON
.5 Fire Alarm status does not match

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.2 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.3 Heating Coil Flow Switch Status does not match command (10 second delay)
.4 Exhaust fan status does not match command (10 second time delay)

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.5 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

3.10 AIR SYSTEM SF-9 CONTROL (SMALL INCINERATOR ROOM VENTILATION)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Small Incinerator Room.

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, an Emergency Supply Air Damper, and a Heating Coil. The Heating Coil is equipped with a Coil Circulation Pump.

.3 There is an Exhaust Fans (EF-427) with an Exhaust Air Damper.

.4 The Supply Fan is equipped with a Variable Speed Drive.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will be commanded to start if one of the following conditions is met:

.1 Small Incinerator Room Temperature is above 26.0 DegC (adjustable), or
.2 The status of the Incinerator is on, or
.3 The System Operator issues a Manual Command.

.2 The Exhaust Fan EF-427 will be started and the Exhaust Fan Damper will open to its Minimum Position (adjustable, initially set at 25%).

.3 When the status of EF-427 is on, the Outdoor Air Damper of Supply Fan SF-9 will be fully opened.

.4 When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-9 will be started and commanded to operate at 100%

.5 When the status of Supply Fan SF-9 is stable, the control loops will be enabled to operate.

.6 On shutdown:

.1 The Exhaust Fan and the Supply Fan will be shut down.
.2 The Outdoor Air Damper and the Exhaust Fan Damper will be fully closed.
.3 The Emergency Supply Air Damper will be fully opened.
.6 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.
.4 When the Outdoor Air Temperature is below the Heating Lockout set point, the Coil Circulation Pump will be started and the Heating Coil Valve

will be modulated to maintain the Heating Coil Discharge Air Temperature set point.

.3 STEADY STATE OPERATION

.1 Supply Fan SF-9 Speed Control

.1 The fan will operate at 100%

.2 Temperature Control

.1 The Heating Coil Valve will be modulated to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.2 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.3 Room Pressure Control

.1 The Exhaust Air Damper will be modulated to maintain the desired Room Pressure Setpoint (adjustable, initially set at 340 Pa).

.4 EMERGENCY MODES

.1 If any of the following conditions occurs, the Supply Fan will be shut down and the Emergency Supply Air Damper will be fully opened:

.1 The status of the Outdoor Air Damper indicates that the damper is closed for more than 60 seconds, or

.2 The Local Mode Switch (EMCS or Emergency) is manually placed in the “Emergency” position.

.2 When the Emergency Mode has been activated, an alarm will be generated and the system will remain in the Emergency Mode for a minimum period of 10 minutes (adjustable). The Local Mode Switch must be manually returned to the “EMCS” position in order to allow the system to re-start normally.

.3 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.4 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Emergency Air Damper status does not match command (60 second time delay)
.2 Pump Status does not match command (10 second delay)
.3 Low Temperature Sensor Alarm status = ON
.4 Fire Alarm status

.2 LEVEL 2 ALARMS

.1 Supply Fan VSD status does not match command (10 second time delay)
.2 Supply Fan VSD Alarm status = ON
.3 Outside Air Damper status does not match command (60 second time delay)
.4 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.5 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.6 Heating Coil Flow Switch Status does not match command (10 second delay)
.7 Exhaust Fan status does not match command (10 second time delay)

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

3.11 AIR SYSTEM SF-10 CONTROL (LARGE INCINERATOR ROOM VENTILATION)

.1 GENERAL

.1 This control sequence applies to the Air System serving the Small Incinerator Room.

.2 The supply air system consists of one 100% outdoor air system. The system has an Outdoor Air Damper, an Emergency Supply Air Damper, and a Heating Coil. The Heating Coil is equipped with a Coil Circulation Pump.

.3 There is an Exhaust Fans (EF-428) with an Exhaust Air Damper.

.4 The Supply Fan is equipped with a Variable Speed Drive.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will be commanded to start if one of the following conditions is met:

.1 Large Incinerator Room Temperature is above 26.0 DegC (adjustable), or
.2 The status of the Incinerator is on, or

.3 The System Operator issues a Manual Command.

.2 The Exhaust Fan EF-428 will be started and the Exhaust Fan Damper will open to its Minimum Position (adjustable, initially set at 25%).

.3 When the status of EF-428 is on, the Outdoor Air Damper of Supply Fan SF-10 will be fully opened.

.4 When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-10 will be started and commanded to operate at its minimum speed (initially set at 25%).

.5 When the status of Supply Fan SF-10 is stable, the control loops will be enabled to operate.

.6 On shutdown:

.1 The Exhaust Fan and the Supply Fan will be shut down.
.2 The Outdoor Air Damper and the Exhaust Fan Damper will be fully closed.
.3 The Emergency Supply Air Damper will be fully opened.
.4 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg
.5 When the Outdoor Air Temperature is below the Heating Lockout set point, the Coil Circulation Pump will be started and the Heating Coil Valve will be modulated to maintain the Heating Coil Discharge Air Temperature set point.

.3 STEADY STATE OPERATION

.1 Supply Fan SF-10 Speed Control

.1 The fan will operate at 100%

.2 Temperature Control

.1 The Heating Coil Valve will be modulated to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).
.3 When the Heating Coil Valve is commanded to more than 5%, the Coil Circulation Pump will be started. The pump will continue to run until the Heating Coil Valve is commanded to less than 2% for 90 seconds (adjustable). The minimum run time of the pump is 300 seconds (adjustable). The coil circulation pump shall operate continuously at all temperatures below 5 deg C.

.3 Room Pressure Control

.1 The Exhaust Air Damper will be modulated to maintain the desired Room

Pressure Setpoint (adjustable, initially set at 1250Pa).

.4 EMERGENCY MODES

.1 If any of the following conditions occurs, the Supply Fan will be shut down and the Emergency Supply Air Damper will be fully opened:

.1 The status of the Outdoor Air Damper indicates that the damper is closed for more than 60 seconds, or
.2 The Local Mode Switch (EMCS or Emergency) is manually placed in the “Emergency” position.

.2 When the Emergency Mode has been activated, an alarm will be generated and the system will remain in the Emergency Mode for a minimum period of 10 minutes (adjustable). The Local Mode Switch must be manually returned to the “EMCS” position in order to allow the system to re-start normally.

.3 If the Low Temperature Sensor detects an alarm condition (set at 4.0 DegC), the Supply Fan will be shut down as described above and a BMS alarm will be generated. The system must be manually restarted by pressing the button on the face of the Low Temperature Sensor when the alarm condition has been corrected.

.4 When a Fire Alarm is detected, the system will be commanded to the Shutdown Mode as described above. (Fans off, dampers closed, etc)

.5 ALARMS

.1 LEVEL 1 ALARMS

.1 Emergency Air Damper status does not match command (60 second time delay)
.2 Pump Status does not match command (10 second delay)
.3 Low Temperature Sensor Alarm status = ON
.4 Fire Alarm status

.2 LEVEL 2 ALARMS

.1 Supply Fan VSD status does not match command (10 second time delay)
.2 Supply Fan VSD Alarm status = ON
.3 Outside Air Damper status does not match command (60 second time delay)
.4 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.5 Exhaust Air Humidity is more than 5.0 %RH (adjustable) from set point (60 second time delay)
.6 Heating Coil Flow Switch Status does not match command (10 second delay)
.7 Exhaust Fan status does not match command (10 second time delay)

.3 LEVEL 3 ALARMS

.1 Filter Status = ON (change filter)

.4 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

3.12 AIR SYSTEM SF-15/16 CONTROL (BLOCK 500 SUPPLY)

.1 GENERAL

.1 This control sequence applies to the Block 500 Air System.

.2 The supply air system consists of two 100% outdoor air systems which operate as a Lead / Lag pair.

.3 Each outdoor air system has an Outdoor Air Damper, an Isolation Damper, and a Heating Coil and a Cooling Coil, each equipped with a Coil Circulation Pump.

.4 The exhaust air system consists of two exhaust fans which operate as a Lead / Lag pair.

.5 Each exhaust fan has an Exhaust Air Damper and an Isolation Damper.

.6 All fans are equipped with Variable Speed Drives.

.7 The Lead / Lag designation of the Exhaust Fans will be automatically alternated by the BMS once per week (initially scheduled for Wednesday at 1015 hours).

.8 The Lead / Lag designation of the Supply Fans will be automatically alternated by the BMS once per week (initially scheduled for Wednesday at 1045 hours).

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 When the Master Command for Block 500 is commanded to ON, the Air System will be commanded to start.

.2 On start-up:

.1 The Lead Exhaust Fan and the Lag Exhaust Fan will both be started and commanded to operate at its minimum speed (initially set at 25%). When the operation of each fan is stable, the Exhaust Air and Isolation Dampers of the respective Exhaust Fan will be commanded to fully open.

.2 When the status of the Exhaust Air Damper and the Isolation Damper for each Exhaust Fan is proven open by its end switch, the respective fan control loops will be enabled to operate.

.3 When the status of the Exhaust Damper and the Isolation Damper for both Exhaust Fans are proven open by its end switch, the Lead Supply Fan and the Lag Supply Fan will both be started and commanded to operate at its minimum speed (initially set at 25%). When the operation of each fan is stable, the Outdoor Air and Isolation Dampers of the respective Supply Fan will be commanded to fully open.

.4 When the status of the Outdoor Air Damper and the Isolation Damper for each Supply Fan is proven open by its end switch, the respective fan control loops will be enabled to operate.

.5 If the Outdoor Air Temperature is below the Heating Lockout set point (adjustable, initially set at 10.0 DegC), the Heating Coil Circulation Pumps will be started.

.6 If the Outdoor Air Temperature is above the Cooling Lockout set point (adjustable, initially set at 12.0 DegC) and the status of either Chilled Water Pump (P-73 or P-74) is on, the Cooling Coil Circulation Pumps will be started.

.3 On Shutdown:

.1 The Supply Fans will be shut down and associated Isolation Dampers will be fully closed.

.2 After a 30 second time delay the Exhaust Fans will be shut down and associated Isolation Dampers will be fully closed.

.3 The Outdoor Air Dampers and the Exhaust Air Dampers will be fully closed.

.4 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg

.5 The Cooling Coil Circulation Pumps will be shutdown and the Cooling Coil Valves will be commanded to their normal spring return positions.

.3 STEADY STATE OPERATION

.1 The speed of the Exhaust Fans will be modulated in unison to maintain the Exhaust Duct Static Pressure set point (adjustable, initially set at -500 Pa).

.2 At all times the speed of each Exhaust Fan will be overridden to limit the respective Fan Inlet Suction Pressure to a minimum of -1100 Pa.

.3 The speed of the Supply Fans will be modulated in unison to maintain the Supply Duct Static Pressure set point (adjustable, initially set at 400 Pa).

.4 At all times the speed of each Supply Fan will be overridden to limit the respective Fan Outlet Discharge Pressure to a maximum of 600 Pa.

.5 The Heating Coil Valve and the Cooling Coil Valve will be modulated in sequence to maintain the desired Supply Air Temperature Setpoint (adjustable, initially set at 17.0 DegC).

.4 EMERGENCY MODES

.1 When the speed of the Lead Exhaust Fan has been commanded to more than 60% for longer than 3 minutes, the Lag Exhaust Fan will be started and commanded to run at its minimum speed. When the fan is stable the associated Exhaust Damper and Isolation Damper will be fully opened. When the status of the Exhaust Air Damper and the Isolation Damper for the Lag Exhaust Fan is proven open by its end switch, the speed of the fan will be modulated in unison with the speed of the Lead Exhaust Fan.

.2 If the Exhaust Duct Static Pressure remains above -200 Pa for longer than 1 minute, a critical alarm will be initiated to the BMS and the Lag Supply Fan will also be shut down and the associated Outdoor Air Damper and Isolation Damper will be fully closed. The Supply Fans will go through a normal planned startup sequence as described above after the BMS operator has manually commanded the Supply Fan system to restart.

.3 If the Low Temperature Sensor of either Supply Fan detects an alarm condition (set at 4.0 DegC), the respective Supply Fan will be shut down as described above and a BMS alarm will be generated.

.5 FIRE ALARM MODE

.1 The fire signal associated with this system is an alert signal only and does not have any effect on its operation.

.2 System shutdown and isolation can be achieved through a command to the BMS.

.3 Upon activation of a fire alarm system relay dedicated to this system, an alarm reported to the BMS operator.

.6 POWER INTERRUPTION MODE

.1 When there is a power interruption to the supply or exhaust air distribution system for the room then the room will go into a shutdown mode. Start-up will follow the planned start-up operation for the room.

.7 ALARMS

.1 LEVEL 1 ALARMS

.1 Fan VSD status does not match command (10 second time delay)
.2 Fan VSD Alarm status = ALARM
.3 Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)
.5 Low Temperature Sensor Alarm status = ALARM

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)

.3 LEVEL 3 ALARMS

.1 Filter status = ON (change filter)

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.5 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

3.13 AIR SYSTEMSF-17 CONTROL (BLOCK 500 MECHANICAL ROOM VENTILATION)

.1 GENERAL

.1 The system consists of a single exhaust fan and a 100% outdoor air fan system. The air system has a heating coil with a coil circulation pump.

.2 The system normally runs continuously 24 hours/day, 7 days/week.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 On start-up:

.1 The Exhaust Fan EF-503 will be commanded to run.
.2 When the status of the Exhaust Fan is on, the Outdoor Air Damper will be fully opened.
.3 When the status of the Outdoor Air Damper is proven open by its end switch, the Supply Fan SF-17 will be started.
.4 If the Outdoor Air Temperature is below the Heating Lockout set point (adjustable, initially set at 15.0 DegC), the Heating Coil Circulation Pump will be started.
.5 When the status of the Supply Fan is on, the control loops will be enabled to operate.

.2 On Shutdown:

.1 The Exhaust Fan and Supply Fan will be shut down.
.2 The Outdoor Air Damper will be fully closed.
.3 The coil circulation Pump will operate below 5 Deg C outside air and the heating coil valve will modulate to keep the coil discharge temperature at 10 deg C.

.3 STEADY STATE OPERATION

.1 The Heating Coil Valve will be modulated to maintain the desired Supply Air Temperature Setpoint (21.0 °C, adjustable locally).

.4 FIRE ALARM MODE

.1 If a fire alarm condition occurs, the Exhaust Fan will be stopped and the system will go into a shutdown mode.

.5 POWER INTERRUPTION MODE

.1 On short duration power bumps or interruptions (typically <2 seconds), the system will attempt to ride through the power interruption and maintain a steady state operation.

.2 On longer duration power interruptions, the system will not able to remain engaged. The temperature control loops will remain activated for 30 seconds while the emergency generators are started. Once emergency power is active, the fan will restart.

.6 EMERGENCY MODE

.1 On a detection of a Low Supply Temperature (initially set at 4.0 DegC), an alarm will be initiated to the BMS.

.7 ALARMS

.1 LEVEL 1 ALARMS

.1 Low Temperature Sensor Alarm status = ON

.2 LEVEL 2 ALARMS

.1 Supply Air Temperature is more than 2.0° C (adjustable) from set point (60 second time delay)
.2 Fan status does not match command (10 second time delay)
.3 OA Damper status does not match command (60 second time delay)
.4 Pump Status does not match command (10 second delay)

.3 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

.4 If the Low Temperature Sensor detects an alarm condition, the button on the face of the device must be manually pressed to restart the system once the alarm condition has been corrected.

3.14 OUTSIDE AIR TEMPERATURE

.1 A OAT calculated value will be used for all control references. This calculated value will be determined from the four outdoor air temperature sensors. Any individual OAT sensor that is determined to be in error will not be used in determination of the calculated value.

3.15 STEAM BOILER CONTROL PANEL (B-5)

.1 GENERAL

.1 This control sequence applies to the Steam Humidification Boiler B-5.

.2 The system consists of one (1) low pressure (103 kPag) steam boiler. The boiler has a dedicated feedwater system and steam preheater.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will be commanded to start when the System Operator issues a Manual Command. The system will normally operate continuously.

.2 When the system is commanded to start, the Feedwater Pump will be enabled to operate as required by their respective existing controls.

.3 On shutdown:

.1 The Steam Boiler will be shut down.
.2 The Feedwater Pump will be shutdown.

.3 STEADY STATE OPERATION

.1 Feedwater Pump Control

.1 Feedwater Pump will be controlled by the boiler integral level control switch. When the level switch status equals on the feedwater solenoid valve will be opened, after a 5 second delay the feedwater pump will be enabled. After the feedwater switch equals off the pump will be disabled and after a 5 second delay the feedwater solenoid valve will be closed.

.4 ALARMS

.1 LEVEL 1 ALARMS

.1 Boiler Flame Failure Alarm status = ON
.2 Steam Pressure is more than 10 KPa (adjustable) from set point (60 second time delay)

.2 LEVEL 2 ALARMS

.1 Boiler Low Level Alarm status = ON
.2 Pump Status does not match command (10 second delay)
.3 Flow Switch Status does not match command (10 second delay)

.3 LEVEL 3 ALARMS

.1 None

3.16 CHILLED WATER SYSTEM CONTROL

.1 GENERAL

.1 This control sequence applies to the Chilled Water system.

.2 The system consists of two existing Chillers (CH-1 and CH-2), 2 existing chilled water pumps, 2 new chilled water pumps, and two existing Cooling Towers (CT-1 and CT-2), and two existing Condenser Water Pumps. Each cooling tower has a fan, damper, sump heater and a Drain Valve and a Makeup Valve.

.2 PLANNED STARTUP AND SHUTDOWN OPERATION

.1 The system will be commanded to start when the System Operator issues a Manual Command. The system will normally operate continuously.

.2 When the system is commanded to start, the chillers and all pumps will be enabled to operate as required by their respective existing controls.

.3 On shutdown:

.1 The Chillers will be shut down.
.2 The Chilled Water Pumps and the Condenser Water Pumps will be shutdown.
.3 The Cooling Towers will be shut down.

.3 STEADY STATE OPERATION

.1 All components will operate as required by their respective existing controls.

.4 ALARMS

.1 LEVEL 1 ALARMS

.1 Chiller status does not match command (10 second time delay)
.2 Cooling Tower Fan status does not match command (10 second time delay)
.3 Rupture Guard Alarm status = ON
.4 High Condenser Pressure Alarm status = ON
.5 High Purge Alarm status = ON
.6 Refrigerant Monitor Alarm status

.2 LEVEL 2 ALARMS

.1 Pump Status does not match command (10 second delay)
.2 CHW Supply Temperature is more than 2.0° C (adjustable) from set point (600 second time delay)

.3 LEVEL 3 ALARMS

.1 None

.4 All alarms are disabled during a planned shutdown. On a planned startup, the alarms will be delayed for 120 seconds (adjustable).

3.17 WATER SOFTENER CONTROL

.1 Packaged softener control supplied by softener supplier and wired by control contractor.

.2 Water hardness is controlled by measuring the water flow in the soft water line and hard water bypass line via impulse meters and modulating the 2-way control valves in sequence on the hard water line. Control sequence is to be such that flow through the hard water line is initially set at 10% of the flow measured through the soft water line. 15 mm (½”) control valve shall modulate to full open position prior to 40 mm (1½”) control valve opening. Percentage of flow through hard water line to be adjustable from 5% to 25%.

Part 1 General

1.1 SCOPE

.1 System requirements for Local Area Network (LAN) for Building Management System (BMS).

.2 Software Capabilities

.3 Operator Interface

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).

.1	CSA T529-95(R2000)	Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
.2	CSA T530-99(R2004)	Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.

.1	IEEE Std 802.3™-, Part 3	Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)

.1	TIA/EIA-568- March 2004	Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
.2	TIA/EIA-569-A- December 2001	Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

.1	TBITS 6.9- 2000	Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - EMCS - General Requirements.

1.4 SYSTEM DESCRIPTIONS

.1 Data communication network to link Operator Workstations and System Control Units (SCU) in accordance with CSA T529.

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

.1 BMS-LAN and/or WAN

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

.1 BMS Local Area Network (BMS-LAN).

.1 High speed, high performance, local area network over which SCUs and/or ASCs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 BMS-LAN to: BACnet,

.3 Each BMS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of SCUs and OWSs directly connected to BAS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, SCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: twisted cable, shielded twisted cable, fibre optic cable compatible with network protocol to be used within buildings

1.6 ABBREVIATIONS

.1 OIU – Operator Interface Units

.2 SCU – Smart Stand Alone Control Unit

.3 ASC – Application Specific Controller

Part 2 Products

2.1 SOFTWARE FOR CCU

.1 All software provided for CCU operations, including but not limited to, the application program, graphics software, database modification software and user control language software shall be true Microsoft Windows® applications.

2.2 OPERATING SYSTEM AND UTILITIES

.1 Microsoft Windows® 10 based operating system.

2.3 APPLICATION PROGRAM

.1 Provide software to interface between the central computer unit and SCU network, which will allow the following functions:

- .1 Creation and editing of databases, passwords, user control language programs, analog point loop parameters, trends and their setup, logs and their setup, operator access setup and other setup information.
- .2 Provide the capability to backup and store all system databases on the Server, SCUs and ASCs. All database changes shall be performed while the CCU is on line without disrupting other system operations. Database changes shall be automatically recorded and downloaded to the appropriate DDC controller. Similarly, changes made at the DDC controllers shall be automatically uploaded to the CCU, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
- .3 Saving or downloading shall be accomplished with one operation per SCU and must be completed within four minutes maximum per SCU.
- .4 Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows:
  - .1 Dynamic color graphics and graphic control
  - .2 Alarm management
  - .3 Time-of-day scheduling
  - .4 Trend data definition and presentation
  - .5 Graphic definition
  - .6 Graphic construction
  - .7 Split screen - dual graphics

.2 Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:

- .1 Weekly schedules
- .2 Zone schedules
- .3 Monthly calendars

.3 The software being a true Windows application shall provide a graphical user interface and be able to operate in the background concurrently while other windows programs are running. Any alarm condition shall provide a ‘pop-up’ window with choices to be offered.

.4 The software shall incorporate the Microsoft Dynamic Data Exchange (DDE) feature to provide on-line dynamic linking between non-proprietary Windows based software packages such as Word, Excel, dBase, Access, etc. and the databases in the SCU’s, so that all database information including trends, summaries, logs etc. is available to be used in these documents.

.5 Provide online context sensitive help for all control application software.

.6 Provide the capability in the system of accepting database and user control language programs created and edited via a software package running on a PC.

.7 At the end of the warranty period, provide latest versions of software and firmware for:

- .1 Operating System/Utilities
- .2 Application Programs

2.4 DYNAMIC COLOR GRAPHICS SOFTWARE

.1 Dynamic color graphics package which allows user to create, modify and delete graphics through use of a mouse and pull down windows or their equivalent.

.2 Graphics package shall provide:

- .1 Owner creation of symbols which can be stored for future use
- .2 Control of symbol location of screen
- .3 Control of line drawing
- .4 Control of infill color
- .5 Control of alpha numeric texts and information windows
- .6 Two page format for each graphic with the first page being the graphic and the second page being the sequence of operation in written text

.3 Eight color capability for dynamic graphic display.

.4 Mechanism for copying and editing graphics of similar layouts.

.5 Dynamic data display on each graphic which can, accommodate any combination of dynamic (analog or digital) information, graphic symbols and text, displayed at any location on the entire screen.

.6 Automatic update of dynamic data and provide user-defined update internals down to 20 seconds.

.7 Manual or automatic display of graphics. Automatic display to occur as a result of user-definable:

- .1 Alarm occurrence.
- .2 Change of state.
- .3 Specific time, day or date.

.8 The system shall be able to display trends in graphical format, with the exact point value being displayed when the mouse pointer is moved along the displayed graph. A minimum of 5 points shall be able to be displayed at the same time on the graphical display.

.9 A point trend graph shall be defined for every analog input point based on a minimum of 48 samples over a 24 hour period and shall be selected and shown when the point information screen is accessed. For the digital input points, the last 10 changes of state information shall be displayed, indicating the time and date of change. These point trend graphs shall be in addition to any trending of points in trend log groups.

2.5 SCU SOFTWARE

.1 Operator Access

.1 The OIU shall provide full system access to the networked SCU panels through a split screen formatted, self-prompting, menu driven English language interface.

.2 The OIU shall be as defined in BACnet and shall provide for BACnet B-OWS software functionality as per ANSI/ASHRAE 135-2016.

.3 The menu format shall consist of a main menu and as many sub-menus as required to provide full system access and control.

.4 Each menu layer shall be capable of being security protected as defined under the operator access levels.

.5 After system sign on has been completed correctly with user ID and password at the access level the main menu shall automatically appear.

.6 The main menu shall direct the operator further into the system by selection of a menu item number and pressing the return key or using the highlight and return key.

.7 The operator shall be allowed to go backwards through the sub-menu's to the main menu by pressing the ESC key.

.8 From the main menu the operator shall be allowed to the level of access approval:

.1 Direct access any one single point.

.2 Access and modify all information related to a single SCU such as point definitions, control parameters, schedules and system programs.

.3 Set-up log capabilities to include analog and digital trend logs and system entry/exit logs.

.1 Analog trend logging to be both graphic and hard copy with a minimum of 4 points being logged at one time. Operator to be allowed to set sample time, start/stop time and select 4 separately ranged sensors for logging at any given time.

.2 X, Y AXIS for graphics to automatically self-define on selection of sensor.

.3 Operator to be allowed to set start/stop time and date for digital logs.

.4 Operator to have the option of committing any trend log to a history file prior to it being over written.

.4 Determine the operating condition of all SCU's on the system.

.5 Define critical and non-critical alarms for the purpose of having critical alarms designated to the modem for remote annunciation.

.1 Alarm summaries to automatically print point descriptor, time of alarm, type of alarm, and value or status at alarm condition.

.2 Alarms shall show up on the bottom of the screen on all menu's and access levels.

.6 Set-up the operating system time and date, define access levels, system descriptors, auxiliary hardware (printer, modem, phone) phone numbers for modem access and menu formats.

.7 Return back to the user access level.

.8 Menu items having no requirement for a sub-menu on selection will automatically provide the information on the screen.

.9 All required operational changes such as modify, edit, delete, add, and save shall be available through the split screen format on each individual menu and sub-menu.

.2 Operator Access Levels

.1 Provide a minimum of four operator access levels to the system through the use of user-defined passwords.

.1 Level 0 - Normal operator functions such as log and display request, alarm acknowledgment.

.2 Level 1 - All level 0 functions plus analog limit changes, time schedules, point lockouts command functions, modifications or changes to point descriptors, user names, set-up of trend logs, defining of critical and non-critical alarms.

.3 Level 2 - All lower level functions plus access to add, modify or delete user defined parameters, modifications to calculations and access levels.

.4 Level 3 - All lower level functions plus master diagnostics and system access should previous three access levels be accidentally deleted. Level three access to be by the system installer only.

.3 Data Base Creation and Modification

.1 Provide software for data base creation and modification at the central computer and the terminal.

.2 Provide the capability of creating nonphysical, virtual points which can be manipulated in the same manner as analog output and digital output hardware points, and which can store 16-bit floating point mathematics.

.3 Allow for creation of 2 virtual points per hardware point available in the minimum SCU configuration.

.4 The user shall have the minimum data base manipulation capability using one mnemonic for each point in system, while on line, to edit any point, as follows:

.1 Add and delete points.

.2 Modify any point parameter.

.3 Change, point mnemonics.

.4 Change, add or delete engineering units.

.5 Change, add or delete points in start/stop sequences, trend logs, summaries, etc.

.6 Select analog alarm limits.

.7 Adjust analog alarm differentials.

.8 Select points for totalization.

.9 Adjust "change of value" reporting differentials.

.4 Point Control Loops

.1 Provide analog point control loops, resident in each SCU including a three term, proportional, integral, derivative, (PID) control algorithm.

.2 Provide, in each control loop, the following control term "tuning constants" control loop parameters.

.1 Direct or reverse acting

.2 Physical sensor zero and span calibration

.3 Output value to control component

.4 Default set point

.5 Proportional gain

.6 Integral gain

.7 Derivative gain

.8 Sampling time - variable from 1 to 60 seconds

.9 Output low limit

.10 Output high limit

.11 Control loop basis

.3 Provision shall exist for the modification of "tuning constants" by custom-control programs and/or operator while on-line through a terminal.

.5 User Control Language

.1 Provide a single user control language that permits free formatted equations, expressions and comments.

.1 Language input, format and use must be similar to BASIC or other “plain English language” software.

.2 Assembler-style languages or languages that are formatted by calling and linking of library routines are not acceptable.

.3 Language compiler shall have compiler error checking diagnostic features. Compiler shall prevent any inexecutable expression from being compiled.

.2 The system shall allow the user to add, delete and modify the user control language, in any SCU on the network, at any terminal including from a remote location via modem.

.3 User control language shall be totally resident in SCU. Central computer shall not contain any portion of user control language.

.4 The control language shall allow the user to develop and program custom operational sequences, unique control algorithms, interactive point relationships, custom calculations and other relational and logical operators as listed.

.5 Any expression (line of software) shall be able to be composed of 10 mathematical and/or logical operators in any desired order and proportion. Expression shall allow 5 levels of parenthesis and have a minimum logical line length of 128 characters.

.6 Provide mixed mode mathematics (combined use of mathematic and logic operators).

.7 Provide for floating point calculations using following operators:

- .1 Addition, subtraction
- .2 Multiplication, division
- .3 Roots, exponentials
- .4 Natural logarithms

.8 Provide following logical and relational operators in the control language.

- .1 and, or, not , xor
- .2 equal to, not equal to
- .3 less than, greater than, between
- .4 if - then, else

.9 Provide following functions (or subroutines) for inclusion in the user control software:

- .1 Minimum value from a group of values.
- .2 Maximum value from a group of values.
- .3 Timers and delay timers, selectable in seconds, minutes, hours, days.

.10 Provide capability in the SCU to accept any of the system connected point values as valid real time inputs. Also provide capability in SCU to relate real time inputs to user-programmed input values for time of day, day of week, date, constants and previous calculation results.

.11 As a result of software calculations by processor, SCU shall activate system changes such as:

- .1 On-off commands
- .2 Changing system set point and analog output values
- .3 Activating application programs
- .4 Enabling alarm functions
- .5 Defaulting analog control loops
- .6 Enabling/disabling trend logs

.12 Provide for following types of operational sequences, control algorithms, point relationships and custom calculations:

- .1 Calculate and download mixed air temperature set points to mixed air damper control loop
- .2 At calculation result of X or alarm condition of Y close dampers, start circulating pump

.3 At a true result of a number of logical expressions, start motor one wait three minutes, start motor two

.4 Calculate equipment output and energy consumption

.5 Calculate differential temperature and degree days

.6 Calculate metered energy costs

.13 Provide a minimum of ten local variables per custom control program for use as temporary storage of intermediate calculation results. These variables must be capable of storing 16 bit numbers and shall not have to be created by the user.

.6 Alarm Processing and Reporting

.1 Provide alarm processing and reporting to user-defined peripherals.

.2 All alarms shall be unique and definable, on a per point basis, on-line by an operator.

.3 Alarms shall be enabled and disabled on-line by the Operator on a per point basis, per system basis and per building basis.

.4 Provide at a minimum:

.1 Two (2) alarm limits (i.e.) high and low on all analog input, calculated and accumulator points.

.2 The designation of one (1) state or condition for all digital inputs as an alarm condition.

.3 Deviation from setpoint alarms on all DDC control loops.

.4 "Failure to Execute" alarms for all BMS commanded control, start, stop or other interlock sequence of actions.

.5 Other alarms as defined elsewhere within this specification.

.5 Provide audible and visual annunciation of each alarm occurrence.

.6 Alarm messages shall at a minimum contain:

.1 The time and date of the alarm

.2 The point mnemonic

.3 A concise, unique, English language description of the point

.4 A concise description of the alarm condition

.7 Audible annunciation shall be continuous or repeating until all unacknowledged alarms have been acknowledged.

.8 Audible alarm annunciation tone and volume shall be adjustable. Operator shall be able to enable or disable audible annunciation.

.9 An active alarm list window shall list alarm messages for all active system alarms and all alarms that have not been acknowledged.

.1 The alarm list shall clearly differentiate (preferably by the use of color) unacknowledged alarms still in alarm state, unacknowledged alarms that have returned to normal and acknowledged alarms.

.2 Acknowledged alarms that are no longer in the alarm state shall be removed from the alarm list.

.3 Provide a report to print the current alarm list to a user-defined peripheral.

.10 A global acknowledge function shall permit the operator to acknowledge all alarms currently displayed in the alarm list window.

.11 Digital Alarms

.1 The Operator shall be able to define which contact state is alarm state.

.2 Provide automatic disabling of alarm at shut down of associated equipment.

.3 Provide command failure alarms when the status does not match commanded status after an operator adjustable time delay.

.12 Analog Alarms

.1 Provide automatic disabling of alarm on associated equipment shut down and an operator adjustable time delay on equipment start-up.

.2 Provide an Operator adjustable time delay and deadbands on all analog alarms. The time delays and deadbands shall be assignable on an individual point basis.

.13 Critical vs. Non-Critical

.1 Provide the capability for the user to differentiate between critical and non-critical alarms. Critical alarms shall be acknowledged by user.

.14 Networking and Controller Alarms

.1 Provide alarming for communication failures on all segments of the network.

.2 Provide alarming for all controller failures, resets and reloads.

.3 Retain a log separate from the transaction log of all network communication failures, controller failures, resets and reloads.

.7 Transaction Logging

.1 Provide transaction logging to retain a historical log of every system event including:

.1 Equipment status changes

.2 Alarms

.3 Alarm return to normal

.4 Operator commands.

.5 Database changes

.2 Transaction logging shall be configurable for printing to user-defined peripherals and shall be retained in an electronic log file that can be reviewed and printed.

.3 Transaction log entries shall at a minimum contain the following:

.1 Time and date of each event

.2 The event type (i.e. Alarm, Status, Command etc.)

.3 The point mnemonic

.4 A concise, unique, English language description of the point

.5 A concise description of the alarm condition

.6 The logged on operator for commands.

.8 Reporting

.1 All reports shall be available to the Operator on a scheduled and on-demand basis.

.2 The time and date shall be recorded on all reports.

.3 Reports shall contain point mnemonic identifiers and associated expanded English descriptors.

.4 Provide the means to terminate the printing of a report in progress.

.5 Reports shall be available including at a minimum:

.1 All point or System Summary report showing all points in the system, their current value and if they are disabled, on hand or in alarm. The points shall be sorted by system and the report shall be selectable for individual systems.

.2 Complete point definition reports showing all of the points in the DDC system and their current configuration (alarm limits, addresses, etc.)

.3 Alarm/Point Disabled status reports.

.4 Alarm Summary reports.

.5 Equipment Schedule reports for operator selected ranges of equipment that show all scheduled start and stop times.

.6 Other reports as defined elsewhere within these specifications.

Part 3 Execution

3.1 INSTALLATION

.1 Perform following functions with mass storage device:

.1 Acquire information from, process, and transfer information to the SCU's, and system peripherals as required.

.2 Provide control system backup function by saving to mass storage, database, user control language programs and other required information.

3.2 GRAPHIC INSTALLATION

.1 Provide fully installed dynamic graphics for all the HVAC and associated systems, including room control. The terminal room control shall be detailed on graphical building floor plans.

.2 The BMS contractor will provide schematics for desired graphic layout.

.3 Where possible all points in a system shall be included on a single graphic.

.4 The dynamic graphics will indicate all points as contained in the points list.

.5 Ensure that inputs, outputs and set-points are easily distinguishable on graphics as are points that are on manual control.

.6 The above noted graphic displays may be reorganized, to improve the system illustration.

.7 Submit system schematic to the Engineer as a shop drawing for approval prior to finalization and installation. Make changes to graphics at the shop drawing stage as instructed by the Engineer at no additional cost to the Owner.

.8 All graphics shall display the outside air temperature and outside air humidity.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Workstation (OWS)

1.2 GENERAL

.1 The BMS contractor shall include for the necessary software updates required in the existing Workstations on site that access the BMS system.

Part 2 Products

Not Used

Part 3 Execution

Not used

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Complete BMS system.

.2 Networked SCU control system.

.3 Networked ASC control system

.4 Operator I/O

.5 Hardware/software to meet applications specified.

.6 Control devices, components, wiring and material.

.7 Server

.8 Instructions to Owner.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1	ASHRAE 2003	Applications Handbook, SI Edition.

.2 Canadian Standards Association (CSA International).

.1	C22.2 No.205-M1983(R1999)	Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1	IEEE C37.90.1- 02	Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

.4 Public Works and Government Services Canada (PSPC)/Real Property Branch/Architectural and Engineering Services.

.1	MD13800- [September 2000]	Energy Management Control System (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.3 ABBREVIATIONS

.1 CSA – Canadian Standards Association

.2 UL – Underwriters Laboratory

.3 OIU – Operator Interface Unit

.4 SCU – Smart Standalone Control Unit

.5 ASC – Application Specific Controller

.6 ECU DEFINITIONS

.7 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM UPGRADE

.1 The point types identified in the point schedule shall be provided at the ASC's and SCU's under this contract. Field hardware for system expansion shall not be provided under this contract.

.2 As part of the system upgrade the existing ADX server shall be replaced and a new ADX-10 server and shall support the 64-bit Windows Win Server 2016 software along with Metasys 10.x software.

.3 The existing data base and graphical software shall also be updated to correspond with the new server.

1.5 DESCRIPTION

.1 General: Network of controllers comprising of SCU('s), to be provided as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Consultant at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with another controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.3 Interface to include provisions for use of internet connection for remote access.

1.6 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog input signals to digital format with [14] bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0 - 10 V DC;

.3 100/1000 ohm RTD input;

.3 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 12 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.3 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

.4 Controllers: mount in existing BMS panels

.1 Provide for conduit entrance from top, bottom or sides of panel.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures Section 25 05 02 - EMCS: Submittals and Review Process.

.1 Submit product data sheets for each product item proposed for this project.

1.8 MAINTENANCE

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

Part 2 Products

2.1 Regulatory Requirements

.1 Provide equipment with CSA, ULC approval.

2.2 SCU System Description

.1 The term Standalone Control Unit (SCU) shall refer to "smart" remote field programmable digital system controller, microprocessor based, capable of independent operation.

.2 Provide complete and fully operational smart standalone processing units as required to meet the specified requirements and in accordance with applicable codes and regulations.

.3 SCU's in individual buildings shall be networked to permit full data base sharing between all SCU's in that building.

.4 Major components of each SCU:

.1 Native BACnet – BTL, ASHRAE 135-2016 BACnet standard

.2 Memory – dynamic, FLASH EEPROM

.3 Communication – The SCU shall be capable of BACnet I/P, MS/TP BACnet over Ethernet, BBMD support. The SCU shall be provided with an IEEE 802.3 Ethernet 10/100 BaseT 10Mbps plug-in network interface card, BACnet MS/TP field controller bus, and Service Port

.4 MS/TP Nodes – support a minimum of 32, speed selectable 9600 to 76.8k baud. Maximum number of nodes per MS/TP trunk is 60.

.5 SNMP Monitoring – alarming

.6 Automatic Restart after Power Failure – upon restoration of power after an outage the SCU shall automatically, without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

.7 IO, Modular / Expandability – ability to directly control I/Os via built in and/or expansion modules. All I/Os to be as per B-AAC inputs and outputs.

.8 Programming / the SCU shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. The software shall be ‘Plain English’ and/or ‘BASIC’ like language.

.9 Provide adequate filtration within the SCU or via an external device to ensure SCU operation and program execution are not affected by power line transients.

.10 Battery Back-up: Minimum of 24 hours with automatic battery charger.

.11 Instrumentation to satisfy the requirements of the input/output schedule connected directly to the appropriate SCU.

.12 Computer software to satisfy requirements to monitor and control the system as required, including all math and control loop routines as specified.

.5 The SCU shall be equipped with non-volatile memory or sufficient firmware to allow for power failure or battery failure. Software loading from a floppy disk or cassette would be acceptable for this purpose. Minimum time for re-loading to be less than 4 minutes.

.6 The SCU shall be capable of downline loading from a remote device. Time for downline loading not to exceed 4 minutes.

.7 On a failure of an SCU all points and systems controlled shall automatically revert to a "fail safe" condition.

.8 SCU shall continue to control its data environment on failure of communications network.

.9 Minimum ambient conditions for equipment unless otherwise noted:

.1 .1 5 to 35°C (41 to 95°F)

.2 .2 10 to 90% RH (non-condensing)

.3 .3 120 VAC ± 10%, 60 Hz ± 1%, single phase

.10 Equipment shall meet required specifications when subject to radio frequency interference (RFI) field levels of 5 volts/meter at a frequency range of 100 kHz to 400 MHz

.11 Contract documents for the SCU system specify general installation instructions. Any error or omission noted by the Contractor must be identified to the Engineer for clarification before proceeding with the work.

2.3 SCU Power Source

.1 SCU Power

.1 Utilize existing 120/1/60 power to SCU panels

.2 Retain the UPS units. Check the status of the batteries and replace as necessary.

2.4 SCU System Accuracy

.1 Maintain system end-to-end accuracy for two years from sensor to CCU display for the applications specified.

2.5 SCU Nameplates

.1 Retain the SCU cabinets with existing nameplate or nameplate tag.

.2 Provide and install plastic credit card type nameplates for all discrete items of new equipment supplied including:

.1 Sensors

.2 Transmitters

.3 Output devices

.4 Terminal air boxes

.5 Status points

.3 Provide self-adhesive lamicoid labels, attached to operating equipment under computer control as directed by the engineer. Labels have white letters on red background stating:

WARNING

This equipment operates under computer control and may start at any time. Phone for instructions before operating.

.4 Submit sample for approval by Engineer.

2.6 SCU Real Time Operating System

.1 Provide a real-time operating system with the following capabilities:

.1 Execute programming control, timing and sequencing of all programs.

.2 Perform multiple tasking to run programs and concurrently to interface with I/O devices, compile, edit and debug programs while protecting system memory.

.3 Maintain and control time initiated commands, signals and printouts by means of a real time clock program routine.

.4 Provide orderly shutdown of system on power failure to units and an automatic restart of system when power restored.

.5 Provide sequenced timing chain for restart of shut down equipment on restoration of power.

.6 Provide saving of user control software programs and data base onto CD to facilitate system reloading.

.7 Provide diagnostic software to test SCU, and data transmissions.

.8 Provide programming support software which:

.1 Compiles source code into machine code

.2 Edits source programs

.3 Debugs source and object codes.

2.7 SCU Algorithmic Control Sequences

.1 Provide software permitting the creation and execution of algorithmic control sequences for automatic control of equipment based on operational parameters including those defined in the data base. Provide protection for currently running sequences from unauthorized modifications and deletions. All mathematics package functions specified shall be available for use in creating the algorithmic control sequences.

.2 Provisions shall exist for DDC setpoints as stored in SCU software, to be derived from:

.1 Manual input from the remote keyboard/CRT or the integral SCU keyboard.

.2 As a bias plus some other system value held within the same SCU or other SCU on the same communication network.

.3 From the input, setpoint or output of some other DDC loop within the same SCU or other SCU on the same communication network.

.4 By defined calculated means. The logic required for the calculation shall exist at the SCU.

.3 Three term (proportional-rate-reset) software direct digital control algorithms shall be provided within the SCU software. Provision shall exist for the on-line modification by the operator.

.4 These P.I.D. control loop parameters shall at minimum include:

.1 setpoint

.2 proportional gain

.3 derivative gain

.4 integral gain

.5 direct/reverse acting

.6 time step

.7 upper limit for integral control

.8 lower limit for integral control

.9 auto/manual

.5 Provision shall exist in the DDC algorithms to prevent the occurrence of integral wind-up.

.6 Provision shall exist in the DDC algorithms to provide output range limiting in a flexible manner on a per loop basis.

.7 Provision shall exist for bumpless transfer between manual and automatic DDC control modes.

.8 Provision shall exist for the on-site development and commissioning of control strategies between individual controlled loops including, though not necessarily limited to:

.1 Two position control

.2 Ratio control

.3 Output bias control

.4 Cascade control (master sub-master)

.5 Lead/lag compensation

.6 Feed forward

.7 Logic control.

2.8 SCU Self-Diagnostics and Alarm Reporting

.1 Each stand-alone control unit shall contain self-diagnostics that continuously monitor the proper operation of the unit. A malfunction of the unit shall be reported at the building control center and will inform the operator of the nature of the malfunction, and the control unit affected.

2.9 System Description

.1 The SCU shall be able to extend its performance with the use of Application Specific Controllers (ASC)s with the ASC to provide for independent operation with linking back to the SCU.

.2 Various types of ASC's shall be provided according to the specific application, such as fan coils, VAV boxes, package HVAC units, terminal control, etc. The ASC's shall be BACnet B-AAC or B-ASC type controllers.

.3 BACnet Advanced Application Controller (B-AAC):

.1 Native BACnet – BTL, ASHRAE 135-2016 BACnet standard

.2 Memory – dynamic, FLASH backup

.3 Communication – The B-AAC shall provide a BACnet BTL MS/TP port communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the B-BC online. It shall be possible from a service port on any B-AAC to view, enable/disable and modify values of any point.

.4 MS/TP - speed selectable 9600 to 76.8k baud.

.5 Power Overload Protection – fused MOV protected

.6 Switches – reset individual output switches

.7 Automatic Restart after Power Failure – upon restoration of power after an outage the B-AAC shall automatically, without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

.8 IO, Modular / Expandability – ability to direct control to additional I/Os via expansion modules.

.9 Real Time Clock / Include a battery or capacitor backed real time clock accurate to +/- 1 second per day and shall be synchronized with the SCU.

.10 Programming / the B-AAC shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. The software shall be ‘Plain English’ and/or ‘BASIC’ like language.

.11 Provide adequate filtration within the SCU or via an external device to ensure SCU operation and program execution are not affected by power line transients.

.12 Battery Back-up: Minimum of 24 hours with automatic battery charger.

.13 Instrumentation to satisfy the requirements of the input/output schedule connected directly to the appropriate SCU.

.14 Computer software to satisfy requirements to monitor and control the system as required, including all math and control loop routines as specified.

.4 BACnet Application Specific Controller (B-ASC):

.1 The B-ASC shall be designed for standalone control of terminal systems i.e. VAV boxes, fan coils, force flows, etc.

.2 Native BACnet – BTL, ASHRAE 135-2016 BACnet standard

.3 Memory – dynamic, FLASH backup

.4 Communication – The B-ASC shall provide a BACnet BTL MS/TP port communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the B-BC online. It shall be possible from a service port on any B-ASC to view, enable/disable and modify values of any point.

.5 MS/TP - speed selectable 9600 to 76.8k baud.

.6 Power Overload Protection – fused MOV protected

.7 Automatic Restart after Power Failure – upon restoration of power after an outage the B-AAC shall automatically, without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

.8 Programming / the B-ASC shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. The software shall be ‘Plain English’ and/or ‘BASIC’ like language.

.9 Provide adequate filtration within the SCU or via an external device to ensure SCU operation and program execution are not affected by power line transients.

.10 Battery Back-up: Minimum of 24 hours with automatic battery charger.

.11 Instrumentation to satisfy the requirements of the input/output schedule connected directly to the appropriate SCU.

.12 Computer software to satisfy requirements to monitor and control the system as required, including all math and control loop routines as specified.

.13 Separate analog outputs shall be provided for reheat valves, radiation valves, radiant panel valves and damper actuators.

.14 The ASC shall have an auto zero function that automatically calibrates the flow transducer to zero once every 24 hours. The time of day shall be programmable for the functionality to occur.

2.10 Operator Interface

.1 The facility operator shall be able to view and modify setpoints or control strategies from the remote operator’s terminal, from the hand held portable operator’s terminal by plugging into the communications jack and via the modem dial in to the network.

.2 All information shall be displayed in English language format.

2.11 SOFTWARE

.1 General.

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

.3 Include initial programming of Controllers, for entire system.

.2 Program and data storage.

.1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.

.1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by [Consultant] [Departmental Representative] [DCC Representative].

.4 Operator Terminal interface.

.1 Operating and control functions include:

.1 Multi-level password access protection to allow user/manager to limit workstation control.

.2 Alarm management: processing and messages.

.3 Operator commands.

.4 Reports.

.5 Displays.

.6 Point identification.

.5 Pseudo or calculated points.

.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed, or value used to totalize.

.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be SCU or ASC resident functions and form part of CDL.

.6 SCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyses status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will ensure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.

.1 SCU to be capable of providing for the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start stop.

.6 Night setback control.

.7 Enthalpy (economizer) switchover.

.8 Peak demand limiting.

.9 Temperature compensated load rolling.

.10 Fan speed/flow rate control.

.11 Cold deck reset.

.12 Hot deck reset.

.13 Hot water reset.

.14 Chilled water reset.

.15 Condenser water reset.

.16 Chiller sequencing.

.17 Night purge.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Consultant.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 SCUs to accumulate and store automatically run-time for binary input and output points.

.2 SCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 SCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (e.g. KWh, liters, tons, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.12 LEVELS OF ADDRESS

.1 Upon operator's request, BMS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different color, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.13 POINT NAME SUPPORT

.1 Controllers (SCU) to support PSPC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

Part 3 Execution

3.1 SCU INSTALLATION

.1 Install all equipment, accessories, conduit, interconnecting wiring and piping in a neat manner using the latest standards of the industry.

.2 Perform installation with personnel having the relevant skills and experience.

.3 Install equipment stable and fixed to wall or floor. Provide anti-vibration mounts for the proper isolation of the equipment.

.4 Install equipment to allow for easy maintenance access such that it does not interfere with access to adjacent equipment and personnel traffic in the surrounding space.

.5 The LAN cabling shall be 10 Base-T, UTP-8, category 6 or greater with the extension from the I/P outlets in the electrical communication rooms to the SCUs by the BMCS contractor.

.6 Each SCU shall be provided with an existing 120/1/60 power source and associated power supply to provide the reduced voltage and power as required. The power supply may power the associated plug in I/O modules, but shall not be shared with other SCUs and/or ASCs, valve and damper actuators and transducers.

.7 The valve and damper actuators and transducers associated with the SCU requiring 24 VAC/DC shall have separate transformers and/or power supplies, fed from the same 120/1/60 breaker, but with their own power supply and/or transformer. Where required due to load, provide additional power supplies for the auxiliary equipment, including conduit, wire, boxes, etc.

.8 Install equipment stable and fixed to wall or floor. Provide anti-vibration mounts for the proper isolation of the equipment.

.9 Install equipment to allow for easy maintenance access such that it does not interfere with access to adjacent equipment and personnel traffic in the surrounding space.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 BMS Devices and Hardware

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1	Common Work Results for HVAC	Section 23 05 00
.2	Electrical	Division 26

1.3 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).

CSA-C22.1-02	Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.4 DEFINITIONS

.1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

1.6 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 Turn over to the Owner existing materials removed from Work not identified for re-use.

Part 2 Products

2.1 GENERAL

.1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.

.2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.

.3 The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.

.4 The letter under the "Type" column is the same used in the points list.

2.2 BMS PANELS

.1 Mount replacement digital controllers in existing BMS panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.

.2 The existing power supplies, transformers, pilot relays, etc. shall retained and utilized.

.3 Any new BMS panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.

.4 Mount any new BMS panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments inside cabinet and on cabinet face.

.5 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.

.6 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.

.7 Identify all new wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers.

.8 Install bonding conductor between main BMS and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.

.9 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.

.10 Wire "Hand-Off-Auto" selector switches such that safety controls and electrical over current protection are not overridden when selector switch is in the "Hand" position. "Hand-Off-Auto" selector switches shall be provided for all ventilation fans and sump pumps.

.11 BMS power for any new BMS panels shall be from existing 120/1/60 circuits feeding the existing BMS panels.

2.3 RELATED ACCESSORIES

.1 Provide and install all necessary transducers, interposing relays, interface devices, etc. to perform control functions required.

.2 It is the responsibility of the BMS contractor to identify, at the time of quoting, all additional items not specified that are required to meet the operational intent specified.

.3 Items required but not identified at the time of quoting shall be the BMS contractor's responsibility.

2.4 THERMOWELLS

.1 Thermowells shall be pressure rated and constructed in accordance with the system working pressure and constructed of one piece 316 stainless steel.

2.5 MOTORIZED DAMPERS

.1 Motorized dampers supplied under this contract shall be extruded aluminum multiple blade mounted in extruded aluminum flanged frame. Individual blades shall not exceed 150mm (6”) in width or 1200mm (4 ft) in length. Provide interlocking edges and compressible seals of EPDM or silicone. Provide oil impregnated bronze or nylon bearings with additional thrust bearings for vertical blades.

.2 Bearings are to be composed of a Celcon inner bearing fixed to a 11.11mm (7/16") aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

.3 Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

.4 Dampers are to be designed for operation in temperatures ranging between -40°C (-40°F) and 100°C (212°F).

.5 Dampers shall be available with either opposed blade action or parallel blade action. Mixing dampers shall be of opposed blade construction arranged to mix streams. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

.6 Leakage shall not exceed 15.2 $l/s/m^2$ (3 cfm/ft^2) against 0.25 kPa (1”) WG. differential static pressure.

.7 Dampers shall be made to size required without blanking off free area.

.8 Dampers shall be available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".

.9 Installation of dampers must be in accordance with current manufacturer's installation guidelines.

.10 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

.11 Standard of Acceptance: TAMCO Series 1500 Air-Foil Control Damper.

2.6 MOTORIZED DAMPERS – INSULATED

.1 Motorized dampers supplied under this contract and exposed to outside air shall be extruded aluminum multiple blade mounted in extruded aluminum flanged frame. Individual blades shall not exceed 150mm (6") in width or 1200mm (4 ft) in length. Provide interlocking edges and compressible seals of EPDM or silicone. Provide oil impregnated bronze or nylon bearings with additional thrust bearings for vertical blades.

.2 Extruded aluminum damper frame shall not be less than 2.03mm (0.080") in thickness. Damper frame shall be insulated with polystyrene foam on three sides if "Installed in Duct" type and on four sides in "Flanged to Duct" type.

.3 Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and temperature index of 55.

.4 Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

.5 Dampers are to be designed for operation in temperatures ranging between -40°C (-40°F) and 85°C (185°F).

.6 Dampers shall be available with either opposed blade action or parallel blade action. Dampers shall be available with either opposed blade action or parallel blade action. Mixing dampers shall be of opposed blade construction arranged to mix streams. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

.7 Leakage shall not exceed 15.2 $l/s/m^2$ (3 cfm/ft^2) against 0.25 kPa (1") WG. differential static pressure.

.8 Dampers shall be made to size required without blanking off free area.

.9 Installation of dampers must be in accordance with current manufacturer's installation guidelines.

.10 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

.11 Standard of Acceptance: TAMCO Series 9000 Thermally Insulated Damper

2.7 DAMPER OPERATORS

.1 Electronic (De)

  .1 Provide electronic proportional damper actuators with spring return to "fail-safe" in normally open or normally closed position.

  .2 Damper operator's spring return shall have sufficient torque to provide tight shut off in the most extreme expected operating condition.

.3 Modulating damper actuators shall accept a 0 to 10 VDC or 4 to 20 mA BMS signal. and provide a 2 to 10 VDC position feedback signal.

.4 Two position damper actuators shall accept a contact closure or 24 V AC/DC input and provide a dry contract indicating the position of the actuator.

.5 Isolation, smoke, exhaust fan and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or hard wired to start/stop associated fan.

.6 Dampers shall be fully open on a BMS command of 100% and closed on a BMS command of 0%.

.7 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section. The damper area driven by each damper operator shall not exceed 1.6 meters.

.8 Positioning time for full closed to full open not to exceed 90 seconds.

.9 Positioning time for full open to full closed not to exceed 45 seconds.

.10 Where multiple damper actuators are utilized for one damper or multiple damper sections, or where multiple dampers are controlled in unison, all damper actuators shall be controlled by one BMS analog output signal.

.11 Where possible do not mount actuators outdoors or in the air stream.

.12 Where actuators must be mounted outdoors, the actuator shall come with an integral heater and shall be mounted in a weatherproof enclosure.

.13 Where actuators must be mounted in the air stream provide actuators with integral heaters.

.14 Standard of Acceptance – Belimo or Johnson Controls.

2.8 CONTROL VALVES

.1 Provide control valves as indicated on drawings.

.2 Two-way and three-way valves for liquids: Two-way valves shall have equal percentage characteristics and three-way valves shall have linear characteristics.

.3 All valves shall be ball valves with a characteristic disc to provide an equal percentage flow pattern, equal to Belimo CCV valves.

.4 Size two-way valve operators to close against maximum pump shut-off head.

.1 Control valve sizes as shown on drawings.

.1 OR

.2 Size control valves as per following criteria:

.1 Select two-way and three-way control valves for coils, heat exchangers, terminal units, etc., under temperature or humidity control with a nominal pressure drop of 25 kPa (3.6 psi).

.2 Bypass valves shall be sized for 50% of the associated pump head and for 30% of the pump flow.

.3 All two position motorized isolation valves shall be line sized, full port ball valves. For piping 50 mm (2") and under the ball valves shall be without any characteristic disc. Motorized isolation valves 65 mm (2-1/2") and over shall be butterfly valves with seat undercut to 345 kPa (50#) tight shutoff and set up for 90° opening.

.4 Where the valve is smaller than the connected piping, size the valve taking into account any reduction in flow capacity due to difference in sizes.

.3 Where control valves are required for control of unitary devices such as radiator convectors, fin tube convectors, reheat coils, etc., ensure that operator tops are small enough to fit neatly inside corresponding enclosures.

.4 All control valve selections are to be included in shop drawing submission to the Consultant.

2.9 VALVE ACTUATORS

.1 Actuators shall be sized to close the control valve for tight shut-off when operating against maximum system differential pressure and with the installed system pump(s) operating at shut off head.

.2 Valves shall return to normal position on a loss of power as follows:

.1 Preheat, reheat and heating coil valves on central equipment – normally open to coil

.2 Cooling coil valves – normally closed to coil.

.3 Humidifier valves – normally closed to humidifier.

.3 Actuators on valves to have visual mechanical position indication, showing valve position.

.4 Actuators and valves shall be mounted and installed only in the positions approved by the manufacturer. Shop drawings shall clearly indicate acceptable positions.

.5 Electronic Actuators (Ve)

.1 Electronic valve actuators shall have the following minimum performance specifications:

.2 Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation.

.3 Modulating valve actuators must provide proportional valve control in response to a 0 to 10 VDC or 0 to 20ma BMS signal. Two position actuators shall accept a 24 V AC/DC signal for operation.

.4 Modulating actuators shall be equipped with an integral position feedback potentiometer and/or voltage output to indicate the position of the valve. Two position actuators shall have an end switch built into the actuator.

.5 The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation.

.6 Run time of actuator shall be constant regardless of torque and travel time from full open to full close shall not exceed 90 seconds.

.7 Spring return and/or non-spring return control valve operator shall be directly linked to the valve stem through appropriate linkage.

.8 Actuators shall be CSA certified.

.9 Valve actuators installed above ceilings in occupied spaces shall be selected so that noise from valve actuation cannot be detected in the occupied space.

.10 Standard of Acceptance – Belimo or Johnson Controls

2.10 DUCT MOUNT SENSORS

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

2.11 HUMIDITY SENSORS

.1 The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.

.2 The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

.3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

.4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

.5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

.6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

2.12 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 General - Air and Water Pressure Transmitter Requirements:

.1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

.2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

.3 Differential pressure transmitters used in air flow measurement from a flow grid or piezometer ring shall be sized to the flow sensing device and shall be supplied with 'T' fittings and shut-off valves on the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use temporary connection.

.4 A minimum of a NEMA 1 housing shall be provided for the air flow transmitter. Air flow transmitters shall be located in accessible local control panels wherever possible.

2.13 AIRFLOW MEASUREMENT STATION

.1 Provide duct and plenum mounted airflow and temperature measurement devices.

.2 Fan Inlet Air Flow Measuring Stations

.1 At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.

.2 Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm$ 20° in the approaching air stream.

.3 The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.

.4 Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., Ebtron, or Dietrich Standard.

.3 Single Probe Air Flow Measuring Sensor

.1 The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.

.4 Duct Air Flow Measuring Stations

.1 Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

.2 Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4” maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

.3 The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.

.4 The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.

.5 The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.

.6 Total and static pressure manifolds shall terminate with external ports for connection to BMS tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.

.7 Installation Considerations

.1 The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065” WC at 1000 feet per minute, or .23” WC at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.

.2 The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

.3 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

.4 Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.

.5 Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

.8 Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard.

.5 Duct Pressure Traverse Probe

.1 Factory unit duct probes shall be provided where required to monitor duct pressures. The probe shall contain multiple static pressure points located along exterior surface of the cylindrical probe.

.6 Shielded Static Air Probe

.1 A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

.7 Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Cables shall include a terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated. PVC jacketed cables or PVC insulated conductors are not acceptable with ducted sensor probes.

.8 Transmitters

.1 The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor node.

.2 The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.

.3 The transmitter shall have an on-off power switch and operate on 24 VAC. Isolation transformers shall not be required.

.1 The transmitter shall use a switching power supply, fused and protected from transients and power surges.

.2 The transmitter shall use "watch-dog" circuitry to assure automatic reset after power disruption, transients and brown-outs.

.4 All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.

.5 The operating temperature range for the transmitter shall be -28.9° C to 48.9° C (-20° F to 120° F). The transmitter shall be installed at a location that is protected from weather and water.

.6 The transmitter shall be capable of communicating with other devices using one of the following interface options:

.1 Linear analog output signals for airflow and temperature: Field selectable, fuse protected and electrically isolated from all other circuitry, 0-5VDC / 0-10VDC / 4-20mA (4-wire)

.2 RS-485: Field selectable BACnet-MS/TP, BACnet-ARCNET, Modbus-RTU or Johnson Controls N2-Bus

.1 BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

.3 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP

.4 Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a MS Windows -based PC.

.7 The transmitter shall be capable of providing an infra-red interface for manually downloading airflow and temperature data or for uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).

.1 Provide PDA upload/download software for multiple users.

.1 Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.

.2 Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.

.2 Provide a Microsoft Excel file capable of creating test and balance reports from PDA data files transferred to a Windows based PC.

.3 Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows based PC to a PDA for upload to one or more transmitters.

.8 The transmitter shall be capable of identifying a ‘damaged’ sensor node, ignore it and continue to operate by correctly averaging the remaining sensor nodes.

.9 The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.

.1 A written report shall be submitted to the Consultant if any measurement locations do not meet the manufacturer's placement requirements.

2.14 STATUS AND SAFETY SWITCHES

.1 General Requirements

.1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Current Sensing Switches

.1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

.2 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.3 Acceptable manufacturers: Veris Industries

.3 Air Filter Status Switches

.1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 A complete installation kit shall be provided, including static pressure tips, tubing, and fittings.

.3 Provide appropriate scale range and differential adjustment for intended service.

.4 Acceptable manufacturers: Cleveland Controls

.4 Air Flow Switches

.1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

.2 Acceptable manufacturers: Johnson Controls

.5 Air Pressure Safety Switches

.1 Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

.3 Acceptable manufacturers: Siemens Controls

.6 Water Flow Switches

.1 Water flow switches shall be equal to Johnson Controls F61KB-11.

.7 Low Temperature Limit Switches

.1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

.2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

.4 The low temperature limit switch shall be equal to Johnson Controls A70.

2.15 TEMPERATURE SENSORS

.1 General: to be resistance type to following requirements.

.2 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, nominal insertion length.

.2 Averaging duct type incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

.3 Outdoor air temperature sensors:

.1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating conduit, weatherproof construction in NEMA 4 enclosure.

2.16 HUMIDITY SENSORS

.1 Duct Requirements:

.1 Range: 5 - 90 % RH minimum.

.2 Operating temperature range:0 - 60 degrees C.

.3 Absolute accuracy:

.1 Duct sensors: plus or minus 3 %.

.2 Room sensors: plus or minus 2 %.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.

.6 Duct mounted sensors: locate so that sensing element is in air flow in duct.

2.17 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA or 0-10 V DC.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit shall be equal to SETRA 264 series.

2.18 TEMPERATURE SWITCHES

.1 Requirements:

.1 Operate automatically. Reset automatically, except as follows:

.1 Low temperature detection: manual reset.

.2 High temperature detection: manual reset.

.2 Adjustable setpoint and differential.

.3 Accuracy: plus or minus 1 degrees C.

.4 Snap action rating: Switch to be DPST for hardwired and BMS connections.

.5 Type as follows:

.1 Duct, general purpose: insertion length = 460 mm nominal

.2 Low temperature detection: continuous element with 6000 mm nominal insertion length, duct mounting, to detect coldest temperature in any 30mm length.

2.19 CURRENT TRANSMITTERS

.1 Combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.

.2 0-1 volt DC.

.3 0-10 volts DC.

.4 0-20 volts DC.

.2 Frequency insensitive from 10 - 80 hz.

.3 Accuracy to 0.5% full scale.

.4 Zero and span adjustments. Field adjustable range to suit motor applications.

.5 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.20 CURRENT SENSING RELAYS

.1 Requirements:

.1 Suitable to detect belt loss or motor failure.

.2 Trip point adjustment, output status LED.

.3 Split core for easy mounting.

.4 Induced sensor power.

.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.

2.21 ANALOG INPUT SENSOR TYPES

.1 Temperature

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
Mounted		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side
Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	Must be usable over 0 to 100% RH Range
Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
Outside air	Ho	5 - 100% RH	±5%	Must be usable over 0 to 100% RH Range; c/w solar-shield

.3 Pressure

Application	Type	Operating Range	End to End Accuracy	Remarks
Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
		0 to 208 kPa (0 to 30 psi)	±2%	
		0 to 689 kPa (0 to 100 psi)	±2%	
		0 to 2,000 kPa (0 to 300 psi)	±2%	
Static-air	Sp	0 to 500 Pa (0 to 2" WG)	±2%	
		0 to 1,250 Pa (0 to 5" WG)	±2%	
		0 to 2,500 Pa (0 to 10" WG)	±2%	
Instrument	Ia	0 to 150 kPa (0 to 20 psi)	±2%	
Velocity pressure monitoring station – air	Vp	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±1.0%	-multi-point static & total pressure sensing element manifold -self-averaging manifold -air equalizer & straightener -max. pressure loss 36 Pa @ 10 m/sec. -lowest sensitivity 1% of range

Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±3.0%	Multiple total and static pressure sensors connected to a self averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

.4 Electrical

Application	Type	Operating Range	End to End Accuracy	Remarks
Kilowatts	kW	As required	±0.25% full scale	From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

.5 Miscellaneous

Application	Type	Operating Range	End to End Accuracy	Remarks
Carbon Dioxide	CO2	300 to 2000 PPM	±5% full scale	Device must not be sensitive to ambient air temperature or relative humidity
Generic	AIi	4 to 20 mA DC	±0.25%	
Analog Inputs	AIv	0 to 10 VDC	±0.25%	

2.22 ANALOG OUTPUT DEVICE TYPES

Application	Type	Operating Range	End to End Accuracy	Remarks
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

Controller Setpoint Reset	Csr	4 to 20 mA DC 0 to 10 VDC	±0.25% full scale
Variable Speed Drive	Vsd	4 to 20 mA DC 0 to 10 VDC	±0.25% full scale
Generic Analog Outputs	AOi	4 to 20 mA DC	±0.25%
	AOv	0 to 10 VDC	full scale

2.23 DIGITAL INPUT DEVICE TYPES

Application	Type	Operating Range	End to End Accuracy	Remarks
Dry Contact	Rc	N/A	N/A	
End Switch	Esw	N/A	N/A	
Level Switch	Lsw	N/A	N/A	Adjustable setpoint and differential; Pressure suitable to application
Pressure Switches	Psw	As required	±1.5% full scale	Adjustable setpoint and differential
Temperature Switch	Tsw	As required	±1°C	Adjustable setpoint and differential; Manual reset for freeze protection
Current Sensing Relays	Ri	As required	N/A	Adjustable setpoint and differential
Motor status Relays	St	As required	N/A	-auxiliary contacts
Level	Ls	N/A	N/A	

2.24 DIGITAL OUTPUT DEVICE TYPES

Application	Type	Operating Range	End to End Accuracy	Remarks
Relays	Ry	N/A	N/A	DPDT; Plug-in type terminal base; Contacts rated to suit motor starter
E/P Relays	Ep	N/A	N/A	

Part 3 Execution

3.1 GENERAL

.1 Codes and Standards

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.

.2 Current relay modules shall be SENTRY series 100/200 series to provide a 4-20ma or 0-10VDC signal according to the motor current, with frequency variations from 10 to 400 Hz.

.3 Current sensing relays shall be Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.

.4 Air pressure switches shall be mounted in the BMS panel, with the tubing extended out to the unit.

.5 Static and differential air pressure transmitters shall be Dwyer DPT 264 series, 0.5% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BMS.

.6 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, with duct clamp and gasket for sensing the total and/or static pressure. For static pressure measurements extend the second reference line connection from the panel to a point outside and adjacent to the pitot tube. Leave the line open and tag it indicating the line is to be kept open. Provide capped fittings at the pitot tube for connection of a remote gauge.

.7 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices. Power to be taken from the existing 120/1/60 power circuits in the BMS panels.

3.2 INSTALLATION

.1 Verify location of thermostats and other exposed BMS sensors with drawings before installation. Locate room thermostats and sensors 1500mm (5 ft) above floor.

.2 Install damper motors on outside of ducts. Do not locate in outside air stream.

.3 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.4 Fans that are to be sequenced with intake or discharge dampers through a single output point, shall be wired such that operation of damper end switch alone will not start fan i.e. the damper actuator end switch and BMS fan relay auxiliary contact must both be required to start the fan when the "hand/off/auto" selector switch is in the auto position.

.5 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.6 Install all safety limits at the operator’s level.

.7 Safety devices including but not limited to freeze stats and pressure switches shall be hardwired to trip fan starters on alarm condition. Auxiliary contacts shall be wired back to thermostats.

3.3 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

  .1 Protect from solar radiation and wind effects by non-corroding shields.

  .2 Install in NEMA 4 enclosures.

.4 Duct installations:

  .1 Do not mount in dead air space.

  .2 Locate within sensor vibration and velocity limits.

  .3 Securely mount extended surface sensor used to sense average temperature.

  .4 Thermally isolate elements from brackets and supports to respond to air temperature only.

  .5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.

  .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

  .2 Wire multiple sensors in series for low temperature protection applications.

  .3 Wire multiple sensors separately for temperature measurement.

  .4 Use software averaging algorithm to derive overall average for BMS purposes.

.6 Thermowells: install for piping installations.

  .1 Locate well in elbow where pipe diameter is less than well insertion length.

  .2 Thermowell to restrict flow by less than 30%.

  .3 Use thermal conducting paste inside wells.

3.4 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Sequence of Operation requirement of each system.

1.2 SEQUENCING

.1 General

.1 Provide the database for all physical points listed in the Point Schedule, software points through the serial BACnet connection and virtual data base points

.2 Provide all programming required to implement the BMS sequences in the new equipment that replicates the existing sequences.

.3 Programming style shall remain as per the existing system.

.2 Miscellaneous Requirements.

.1 Motors must not be allowed to start at the same time. Under all conditions of startup from the BMS, return from power failure or panel reset, there must be at least a 5 second delay between the time one motor starts and another is allowed to start.

.2 For each sequence retain separate and unique setpoints, timers, delays, buffers, deadbands, etc. as required by the process. All the values shall be adjustable, through password control for some critical values and shall be adjusted on site during commissioning.

.3 For all motors that are controlled from the BMS or through interlocks, provide the necessary alarm conditions when a motor fails to start after commanded on or stops during normal operation.

.4 Where there is 100% backup of pumps or fans, the BMS shall provide automatic standby operation for the lead pump or fan by automatically starting the lag pump or fan. An alarm shall be initiated in the BMS, requiring operator acknowledgement and the lag pump or fan shall remain operational until the system is reset by the operator. Provide any additional hardware required and provide the necessary delays, buffers, timers, etc.

.5 For the 100% backup of pumps or fans, provide a manual lead/lag command to switch operation of the lead pump or fan. A separate software lead/lag point shall be provided for each dual pump or fan assembly, with the ability for the software lead/lag point to be calendar and or run time programmed. The BMS shop drawings shall indicate one selected mode with the option to select the mode online.

.6 In sequences of operation where modulating motorized valves or dampers are interlocked with motors and the sequence calls for valves or dampers to be fully open or closed when the motor is off, the motorized valve or damper shall be programmed to open or close via software, and the power to the valve or damper shall remain. The spring return feature of motorized valves or dampers shall only be utilized on a true power failure or loss of signal due to broken wires, etc. and not on the associated mechanical device being turned off by the BMS.

.7 Where time programming is indicated the individual time programs shall provide for weekly, daily, holidays, Saturday, Sunday times. For each holiday, a time period of days or weeks shall be able to be

.3 System Sequences & Points List

.1 The sequences and hardware points list for this project will replicate the existing sequences and points, incorporating changes identified according to any mechanical design changes.

.2 The heat recovery aspect of the AHU units shall not be replicated in the sequences.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

System: **Air System SF-1**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Humidifier Valve	Ve				X			
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Static Pressure	Sp					X	XX	**Existing**
Remote Static Pressure #1	Sp					X	XX	**Existing**
Remote Static Pressure #2	Sp					X	XX	**Existing**
Remote Supply Air Volume #1	Vp					X		**Existing**
Remote Supply Air Volume #2	Vp					X		**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Supply Air Humidity	Hp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-2**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Mixed Air Temperature	Ta					X	XX	
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
Min O/A Damper Control	De				X			
Max O/A Damper Control	De				X			
R/A Damper Control	De				X			
Humidifier Valve	Ve				X			
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Static Pressure	Sp					X	XX	**Existing**
Remote Static Pressure	Sp					X	XX	**Existing**
Remote Supply Air Volume	Vp					X		**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Supply Air Humidity	Hp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
E/A Damper Control	De				X			**Existing**
Remote Return Air Volume	Vp					X		**Existing**
Return Air Temperature	Tp					X	XX	**Existing**
Return Air Humidity	Hp					X	XX	**Existing**
Return Fan VFD`	**Same parameters as for supply fan VFDs**							**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-3**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
System Isolation Damper Control	De			X				**Typical of each motorized isolation damper**
System Isolation Damper Status	Dii				X	X		**Typical of each motorized isolation damper**
Humidifier Valve	Ve				X			
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Static Pressure	Sp					X	XX	**Existing**
Remote Static Pressure	Sp					X	XX	**Existing**
Remote Supply Air Volume	Vp					X		**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Supply Air Humidity	Hp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
Remote Transfer Damper Control	Ry	X						**Existing**
Remote Transfer Damper Status	Rc		X					**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-4**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Humidifier Valve	Ve				X			
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Static Pressure	Sp					X	XX	**Existing**
Remote Static Pressure	Sp					X	XX	**Existing**
Remote Supply Air Volume	Vp					X		**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Supply Air Humidity	Hp					X	XX	**Existing**
Fire Alarm	Rc		X	X				**Existing**
Remote Transfer Damper Control	Ry	X						**Existing**
Remote Transfer Damper Status	Rc		X					**Existing**
SF-4 Failure	Rc		X	X				**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-5**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Ri		X					
Start/Stop	Ry	X						
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Mixed Air Temperature	Ta					X	XX	
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
Min O/A Damper	De				X			
Max O/A Damper	De				X			
R/A Damper #1	De				X			
R/A Damper #2	De				X			
Humidifier Valve	Ve				X			
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Return Fan #1 Control	Ry	X						**Existing**
Return Fan #1 Status	Ri		X					**Existing**
Return Fan #2 Control	Ry	X						**Existing**
Return Fan #2 Status	Ri		X					**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Supply Air Humidity	Hp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
Reheat Valve #1	Ve				X			**Existing**
Reheat Valve #2	Ve				X			**Existing**
E/A Damper #1	De				X			**Existing**
E/A Damper #1	De				X			**Existing**
Return Air Temperature #1	Tp					X	XX	**Existing**
Return Air Temperature #2	Tp					X	XX	**Existing**
								Existing

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-6**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFD through BACnet							
Heating Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Humidifier Valve	Ve				X			
Supply Air Humidity	Hp					X	XX	
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
System Isolation Damper Control	De			X				**Typical of each motorized isolation damper**
System Isolation Damper Status	Dii				X	X		**Typical of each motorized isolation damper**
Remote space Humidity	Hr					X	XX	
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Air Temperature	Tp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
Remote Damper Control	Ry	X						**Existing**
Remote Damper Status	Rc		X					**Existing**
Crawl Space Damper Control	Ry	X						**Existing**
Crawl Space Damper Status	Rc		X					**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-7**

POINT DESCRIPTION	*POINT TYPE	DIGITAL			ANALOG			REMARKS
		OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan								**Typical of two fans**
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Heating Coil Flow Switch	Rc		X					
S/A Damper Control	De	X						
S/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
	Existing remote field points associated with the AHU to be reused							
Remote Supply Air Volume #1	Vp					X		**Existing**
Remote Supply Air Volume #2	Vp					X		**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
CO2 Level	COT					X	XX	**Existing**
Mechanical Room Temperature	Tr					X	XX	**Existing**
Emergency Supply Damper	De	X						**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-8**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Ri		X					
Start/Stop	Ry	X						
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Air Temperature	Tp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
Sewage Room Temperature	Tr					X	XX	**Existing**
Exhaust Fan #1 Status	Rc		X					**Existing**
Exhaust Fan #1 Start/Stop	Ry	X						**Existing**
Exhaust Fan #2 Status	Rc		X					**Existing**
Exhaust Fan #2 Start/Stop	Ry	X						**Existing**
E/A Damper Control #1	De	X						**Existing**
E/A Damper #1 Status	Rc		X					**Existing**
E/A Damper #2 Control	De	X						**Existing**
E/A Damper #2 Status	Rc		X					**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-9**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Air Temperature	Tp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
Incinerator Room Temperature	Tr					X	XX	**Existing**
Exhaust Fan Status	Rc		X					**Existing**
Exhaust Fan Start/Stop	Ry	X						**Existing**
Mode Switch	Rc		X					**Existing**
Exhaust Fan Diff Pressure	Sp					X	XX	**Existing**
E/A Damper Control	De				X			**Existing**
Incinerator Status	Rc		X					**Existing**
Incinerator Alarm	Rc		X					**Existing**
Emergency Damper Control	De		X					**Existing**
Emergency Damper Status	Rc		X					**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-10**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Air Temperature	Tp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**
Incinerator Room Temperature	Tr					X	XX	**Existing**
Exhaust Fan Status	Rc		X					**Existing**
Exhaust Fan Start/Stop	Ry	X						**Existing**
Mode Switch	Rc		X					**Existing**
Exhaust Fan Diff Pressure	Sp					X	XX	**Existing**
E/A Damper Control	De				X			**Existing**
Incinerator Status	Rc		X					**Existing**
Incinerator Alarm	Rc		X					**Existing**
Emergency Damper Control	De		X					**Existing**
Emergency Damper Status	Rc		X					**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air Systems SF-15 & SF-16**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								**Typical of two fans**
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
Isolation Damper Control	De	X						
Isolation Damper Status	Rc		X					
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								**Typical of two pumps**
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								**Typical of two systems**
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Cooling Coil Valve	Ve				X			
Preheat Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Supply Static Pressure	Sp					X	XX	**Existing - Typical of two systems**
Remote Static Pressure	Sp					X	XX	**Existing**
Supply Air Temperature	Tp					X	XX	**Existing**
Fire Alarm	Rc		X	XX				**Existing**

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Air System SF-17**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Supply Fan								
Status	Rc		X					**Auxiliary contact in VFD**
Start/Stop	Ry	X						
Speed Control	VFD				X			
Fan Speed	VFD					X		**Program as Hz**
VFD Alarm	VFD		X	X				**Auxiliary contact in VFD**
	Remainder of points for VFDs through BACnet							
Htg Coil Pump								
Status	Ri		X	X				
Start/Stop	Ry	X		X				
System								
Filter	Sp					X	XX	
Heating Coil Valve	Ve				X			
Supply Air Temperature	Ta					X	XX	
Low Temperature	Td		X	X				
O/A Damper Control	De	X						
O/A Damper Status	Rc		X					**Wire multiple damper contacts in series as per existing**
Heating Coil Flow Switch	Rc		X					
	Existing remote field points associated with the AHU to be reused							
Exhaust Fan Status	Rc		X					**Existing**
Exhaust Fan Start/Stop	Ry	X						**Existing**
Zone Temperatire	Tr				X	XX		

*** Refer to Spec Section 25 30 02 For Point Type Specifications**

System: **Steam System**

POINT DESCRIPTION	*POINT TYPE	DIGITAL OUTPUT	DIGITAL INPUT	DIGITAL ALARM	ANALOG OUTPUT	ANALOG INPUT	ANALOG ALARM LIMITS	REMARKS
Boiler								
Status	Rc		X					
Steam Pressure Setpoint	Is				X			
Start/Stop	Ry	X						
Common Alarm	Rc		X	X				
	Remainder of points for Boiler through BACnet							
Feedwater Pump								
Status	Ri		X	X				
Enable	Ry	X		X				
System								
Steam Pressure	Ps					X	XX	
Feedwater Temperature	Tw					X	XX	
Blow Down Panel alarm	Rc		X					**Dry contact in panel.**
Blow Down Tank Pressure	Ps					X	XX	

*** Refer to Spec Section 25 30 02 For Point Type Specifications**