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1.1 DESCRIPTION OF WORK

.1 Site of Work is: Laboratory Block-C, Agriculture and Agri-Food Canada, Kentville Reasearch Centre, 32 Main Street, Kentville, Nova Scotia.

.2 In general, work under this contract includes, but is not limited to, the supply of all equipment, material, controls, services, and personnel required to complete the following:

- .1 Perform new structural reinforcing work in Mechanical Penthouse. Remove redundant services and equipment and temporarily relocate existing mechanical and electrical services to allow Laboratories to remain in operation during structural renovations.
- .2 Install new Lab Exhaust plenum and new Roof-Mounted Fume Hood Exhaust Fans FF-1 and FF-2. Commission new Fume Hood Exhaust plenum and new Fume Hood Fans.
- .3 Install new General Exhaust Fan GE-1 and make modifications to EXISTING General Exhaust Plenum. Commission new GE-1 fan and place in service. GE-1 modifications and fan install and commissioning must be done over a weekend, so that General Exhaust System will be operational by 7:00am Monday morning to service operating Laboratories.
- .4 Install and commission New DDC Laboratory Control System infrastructure to control FF-1, FF-2, GE-1, and control back-bone to allow individual Labs to be added to the EMCS as they are renovated and put back in operation.
- .5 Installation of new DDC Control System for Supply Air Units 5A & 5B prior to starting individual Laboratory HVAC renovations.
- .6 Replace existing fan motors for supply fans 5A & 5B and return fans RF-5A & RF-5B. Install new VFD drives for new fan motors. This work must be done at night or on weekends.
- .7 Once fans FF-1, FF-2, and GE-1 are commissioned, commence the process of renovating individual Laboratory ventilation, exhaust, and control systems. Only two(2) Laboratories may be taken out of service at a time. Each individual lab cannot be out of service for more than three(3) weeks. Individual Lab controls, ventilation, general exhaust, fume hood exhaust retrofits, commissioning, testing and balancing must be completed in three(3) weeks, so that the Laboratory can be fully operational at the end of the three(3) week period. Scheduling of all Laboratory down-time must be coordinated with and approved by the Departmental Representative.
- .8 During Laboratory shutdown, disconnect existing fume hoods and cap and isolate all services feeding fume hoods. Replace fume hoods with new fume hoods as noted on the drawings, and re-connect all existing services to new fume hoods.
- .9 Existing individual redundant Lab Fume Hood Fans and General Exhaust Fans must be disconnected and removed as each Lab is renovated. Extend ductwork as required and connect existing fume hood ducts to new Fume Hood Exhaust Plenum. Extend ductwork as required and connect existing General Exhaust ducts to new/revised General Exhaust Plenum serving GE-1. Cap and drain existing ducts penetrating the roof until final demolition of redundant roof penetrations and roof repair can be scheduled.

.10 All existing fume hood exhaust ductwork, fans, and equipment serving existing the Perchloric Fume Hoods must be removed. This includes removal of the Perchloric Fume Hoods. All Perchoric Fume Hood equipment, ductwork, and fans must be cleaned and inspected using specialized cleaning procedures prior to removal.

.11 All existing Fume Hood Exhaust ductwork must be cleaned and tested prior to removal or prior to connection to new fume hood ductwork.

.12 Carry out additional mechanical, electrical, and control work in mechanical chases, Basement Mechanical Room, and in the Penthouse as work progresses in individual Laboratories.

.13 Remove all existing redundant ductwork, terminal units, fans, equipment, and controls. Dispose of all redundant materials unless directed otherwise by Departmental Representative.

.14 Remove all existing redundant roof penetrations in the Mechanical Penthouse and 3rd Floor roof and patch roof openings using a qualified roofer.

.15 Perform final TAB and final EMCS start-up and testing.

.16 Perform final cleaning of all spaces affected by construction process.

.17 Perform Final Commissioning and Functional Performance Testing as detailed in Section 23 05 04.

1.2 CODES AND STANDARDS

.1 Perform work in accordance with the 2010 National Building Code of Canada (NBC) and any other code of provincial or local application, including all amendments up to bid closing date, provided that in any case of conflict or discrepancy, the more stringent requirement shall apply.

.2 Perform electrical work in accordance with CSA C22.1-2006. Use only licensed electricians to carry out such work.

.3 Materials and workmanship must meet or exceed requirements of specified standards, codes and referenced documents.

1.3 INTERPRETATION OF DOCUMENTS

.1 For Federal Government projects, Division 01 Sections take precedence over technical specification sections in other Divisions of this Project Manual.

1.4 SETTING OUT WORK

.1 Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.

.2 Provide devices needed to lay out and construct work.

.3 Supply such devices as straight edges and templates required to facilitate Departmental Representative's inspection of work.

1.5 COST BREAKDOWN

.1 Before submitting first progress claim submit breakdown of Contract Amount in detail as directed by Departmental Representative and aggregating contract amount. Required forms will be provided for application of progress payment.

.2 List items of work numerically following the same division/section number system of the specification manual and thereafter sub-divide into major work components and building systems as directed by Departmental Representative.

.3 Upon approval, cost breakdown will be used as basis for progress payment.

1.6 MEASUREMENT PROCEDURES

.1 Refer to Section 01 22 00 Measurements and Payment.

.2 Notify Departmental Representative sufficiently in advance of operations to permit required measurement procedures.

1.7 CONTRACTOR’S USE OF THE SITE

.1 Use of site: limited to areas of work being carried out and as follows:

- .1 Access to all exits must be maintained during normal working hours and where work shall be performed outside of the normal working hours. Access to the building will be via a temporary construction stair to the roof and Penthouse Mechanical Room. Stair to be located at West end of the building contractor will be responsible for securing doors.
- .2 Normal Working Hours defined as:
  - .1 Monday to Friday from 8:00AM to 4:30PM.
  - .2 Work outside of Normal Working Hours must be approved by Departmental Representative.
- .3 Project site security.
  - .1 Where security has been reduced by work of Contract, provide, temporary means to maintain security.
  - .2 Maintain security of construction site by control of access.
  - .3 Maintain security at all times construction is shut down because of a strike or a lockout.
- .4 Limited on-site parking is permitted for construction work force at the construction site. Provide signage to clearly define and separate construction work force parking from the Facility staff parking.
- .5 Limited storage on site is permitted within the construction areas, provided that operations at the Facility are not restricted.
- .6 Do not unreasonably encumber the site with materials and equipment. Move materials and/or equipment as directed by the Departmental Representative which interferes with Facility operations, or with ongoing construction operations of other contracts at the site.
- .7 Move stored materials, products and/or equipment which interfere with the operations of the Facility and the Departmental Representative.
- .8 Maintain mechanical, electrical, and other services to all existing structures on a continuous basis. Disruptions to services are not permitted.

.9 Maintain the access to C-Building for the duration of the Contract. Access for emergency vehicles is to be kept open at all times.

1.8 PROJECT MEETINGS

.1 Schedule and administer project meetings, held on a minimum bi-weekly basis, for entire duration of work and more often when directed by Departmental Representative as deemed necessary due to progress of work on particular situations.

.2 Prepare agenda for meetings.

.3 Notify participants in writing 4 days in advance of meeting date.

.1 Ensure attendance of all subcontractors.
.2 Departmental Representative will provide list of other attendees to be notified.

.4 Hold meetings at project site where approved by Departmental Representative.

.5 Preside at meetings and record minutes.

.1 Indicate significant proceedings and decisions. Identify action items by parties.
.2 Each Meeting shall review schedule and progress to date.
.3 Distribute to participants by mail or by facsimile within 3 calendar days after each meeting.
.4 Make revisions as directed by Departmental Representative.
.5 Departmental representative will advise whether submission of minutes by email is acceptable. Decision will be based on compatibility of software among participants.

1.9 DOCUMENTS REQUIRED

.1 Maintain at job site, one copy each of the following:
.1 Contract Drawings.
.2 Specifications.
.3 Addenda and amendments.
.4 Reviewed Shop Drawings.
.5 List of outstanding shop drawings.
.6 Change Orders.
.7 Other modifications to Contract.
.8 Field Test Reports.
.9 Copy of Approved Work Schedule.
.10 Health and Safety Plan and other safety related documents.
.11 Other documents as stipulated elsewhere in the Contract Documents.

1.10 PERMITS

.1 Obtain and pay for building permit, certificates, licenses and other permits as required by municipal, provincial and federal authorities.

.2 Provide appropriate notifications of project to municipal and provincial inspection authorities.

.3 Obtain compliance certificates as prescribed by legislative and regulatory provisions of municipal, provincial and federal authorities as applicable to the performance of work.

.4 Submit to Departmental Representative, copy of application forms and approval documents received from above referenced authorities.

1.11 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 Where security has been reduced by work of Contract, provide temporary means to maintain security.

.3 Where elevators, dumbwaiters, conveyors or escalators exist in building, only those assigned for Contractor's use may be used for moving workers and material within building. Protect walls of passenger elevators, to approval of Departmental Representative prior to use. Accept liability for damage, safety of equipment and overloading of existing equipment.

.4 Provide temporary dust screens, barriers, warning signs in locations where renovation and alteration work is adjacent to areas which will be operative during such work.

1.12 ROUGHING-IN

.1 Be responsible for obtaining manufacturer's literature and for correct roughing-in and hook-up of equipment, fixtures and appliances.

1.13 CUTTING, FITTING AND PATCHING

.1 Ensure that cutting and patching required by all trades is included in total bid amount submitted for the work.

.2 Execute cutting including excavation, fitting and patching required to make work fit properly.

.3 Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work. This includes patching of openings in existing work resulting from removal of existing services.

.4 Do not cut, bore, or sleeve load-bearing members, except where specifically approved by Departmental Representative.

.5 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.

.6 Fit work airtight to pipes, sleeves ducts and conduits.

1.14 CONCEALMENT

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

1.15 LOCATION OF FIXTURES

.1 Location of equipment, fixtures and outlets, shown or specified shall be considered as approximate. Actual location shall be as required to suit conditions at time of installation and as is reasonable.

.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 when impending installation conflicts with other new or existing components. Follow directives for actual location.

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

1.16 EXISTING SERVICES

.1 Where work involves breaking into or connecting to existing services, carry out work at times directed by governing authorities, with minimum of disturbance to pedestrian, vehicular traffic and Facility operations.

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

.3 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility. This includes disconnection of electrical power and communication services to tenant's operational areas. Adhere to approved schedule and provide notice to affected parties. Provide minimum of 48 hours notice for any closure of active service.

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

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

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

.7 Protect, relocate or maintain existing active services as required. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction over service. Record locations of maintained, re-routed and abandoned service lines.

1.17 ACCEPTANCES

.1 Notify Departmental Representative in writing when work is complete and ready for final inspection.
  .1 Make a check of all work and correct all discrepancies, defects and outstanding work before sending notification.

.2 Accompany Departmental Representative during final inspection.

.3 Rectify all defects, faults and outstanding items identified by Departmental Representative during inspection.

.4 Be aware that the Final Certificate of Completion will not be issued until such time that Contractor has fully completed and turned over all specified as-built project documents, training and maintenance manuals, test results and any guarantee/warranty certificates as issued by any manufacturer.

1.18 WORK COORDINATION

.1 Contractor is responsible for coordinating the work of the various trades and pre-determining where the work of such trades interfaces with each other.
  .1 Designate one person from own employ having overall responsibility to review contract documents and shop drawings and manage such coordination.

.2 Contractor shall convene meetings between trades whose work interfaces and ensure that they are fully aware of the areas and the extent of where interfacing is required.
  .1 Provide each trade with the plans and specs of the interfacing trade, as required, to assist them in planning and carrying out their respective work.
  .2 Develop coordination drawings when deemed required illustrating potential interference between work of various trades and distribute to all affected parties including structural trade.
    .1 Pay particularly close attention to overhead work and within or near building structural elements.
    .2 Coordination drawings to identify all building elements, service lines, rough-in points and indicate from where carious services are coming.

  .3 Review coordination drawings at purposely called meetings. Have subcontractor sign-off on drawings and publish minutes of each meeting.
  .4 Plan and coordinate work in such a way to minimize quantity of service line offsets.
  .5 Submit copy of coordination drawings and meeting minutes to Departmental Representative.

.3 Submission of shop drawings and ordering of prefabricated equipment or prebuilt components shall only occur once coordination meeting for such items has taken place between trades and all conditions affecting the work of the interfacing trades has been made known and accounted for.

.4 Work Cooperation:
  .1 Ensure cooperation between trades in order to facilitate the general progress of the work and avoid situations of spatial interference.

.2 Ensure that each trade provides all other trades reasonable opportunity for the completion of the work in such a way as to prevent unnecessary delays, cutting, patching and the need to remove and replace completed work.

.5 Public Works and Government Services Canada will not be responsible for or held accountable for any extra costs incurred as a result of the failure to carry out coordination work. Disputes between the various trades as a result of their not being informed of the areas and extent of interface work shall be the sole responsibility of the mechanical Contractor and shall be resolved by him at no extra cost to the Contract.

1.19 SANITARY SYSTEM AND SANITARY WASTE TREATMENT

.1 Existing site sanitary system and all sanitary lines shall remain fully functional throughout the duration of the contract.

1.20 OWNER’S OPERATIONS AT THE SITE

.1 Where Owners normal operations at the site are negatively impacted by the operations of the Contractor, the Contractor shall modify, reschedule or otherwise change such construction operations so the Owner’s operations can be maintained. No additional compensation under the contract will be paid to the Contractor as a result of the adjustment of construction operations.

1.21 DEMOLITION PHASING

.1 Removal and proper disposal of hazardous materials see Section 01 33 00 – Submittals.

1.22 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions.

1.23 ASBESTOS DISCOVERY

.1 Demolition of spray or trowel-applied asbestos can be hazardous to health. Should material resembling spray or trowel-applied asbestos be encountered in course of work, stop work and notify Departmental Representative immediately. DO not proceed with relevant work until written instructions have been received from Departmental Representative.

1.24 INSPECTION AND TESTING

.1 The Departmental Representative may employ an inspector and/or testing to ensure work conforms with contract.

1.25 SITE CONDITIONS

.1 Protect and/or maintain existing site conditions of areas not directly affected by work under this contract.

1.26 PROGRESSIVE CLEANING

.1 Maintain site in tidy condition, free from accumulation of waste products and debris.

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

.3 Waste Management
  .1 Refer to Section 01 74 21 – Construction/Demolition Waste Management and Disposal

END OF SECTION

1.1 SUBMITTALS

.1 Upon acceptance of bid and prior to commencement of work, submit to Departmental Representative the following work management documents:
- .1 Work Schedule as specified herein.
- .2 Shop Drawing Submittal Schedule specified in section 01 33 00.
- .3 Waste Management Plan specified in section 01 74 21.
- .4 Environmental Plan specified in section 01 35 43.
- .5 Health and Safety Plan specified in section 01 35 29.
- .6 Hot Work Procedures specified in section 01 35 24.
- .7 Lockout Procedures specified in section 01 35 25.
- .8 Dust Control Plan specified in section 01 50 00.

1.2 WORK SCHEDULE

.1 Upon acceptance of bid submit:
- .1 Preliminary work schedule within 7 calendar days of contract award.
- .2 Detailed work schedule within 21 calendar days of contract award.

.2 Schedule to indicate all calendar dates from commencement to completion of all work within the time stated in the accepted bid.

.3 Provide sufficient details in preliminary schedule to clearly illustrate entire implementation plan, depicting efficient coordination of tasks and resources, to achieve completion of work on time and permit effective monitoring of work progress in relation to established milestones.

.4 Preliminary work schedule content to include as a minimum the following:
- .1 Bar (GANTT) Charts, indicating all work activities, tasks and other project elements, their anticipated durations, planned dates for achieving key activities and major project milestones supported with;
- .2 Written narrative on key elements of work illustrated in bar chart, providing sufficient details to demonstrate a reasonable implementation plan for completion of project within designated time.
- .3 Generally Bar Charts derived from commercially available computerized project management system are preferred but not mandatory.

.5 Detailed Work Schedule:
- .1 Prepare by use of Critical Path Method (CPM) indicating:
  - .1 Complete and detailed sequence of all construction activities. Show projected start and completion dates for each activity.
  - .2 Number of calendar days required to carryout each activity.
  - .3 Critical path items with resulting critical dates, non-critical activities and resulting float time.
  - .4 Actual workdays from non-working days such as weekend and statutory days etc.
  - .5 Projected and actual percentage of work completed for each major work activity.

.2 Prepare CPM schedule by use of well recognized and widely used electronic software. Submit copy of schedule in paper format and one electronic version for each submission.

.3 Accompany CPM with written narrative as required and in sufficient detail to fully describe work and demonstrate a reasonable implementation plan for completion of project within designated time.

.6 Work schedule must take into consideration and reflect the work phasing, required sequence of work, special conditions and operational restrictions as specified below and indicated on drawings.

.7 Schedule work in cooperation with the Departmental Representative. Incorporate within Detailed Work Schedule, items identified by Departmental Representative during review of preliminary schedule.

.8 Completed schedule shall be approved by Departmental Representative. When approved, take necessary measures to complete work within scheduled time. Do not change schedule without Departmental Representative's approval.

.9 Ensure that all subtrades and subcontractors are made aware of the work restraints and operational restrictions specified.

.10 Schedule Updates:

.1 Submit on a monthly basis when requested by Departmental Representative.

.2 Provide information and pertinent details explaining reasons for necessary changes to implementation plan.

.3 Identify problem areas, anticipated delays, impact on schedule and proposed corrective measures to be taken.

.11 Departmental Representative will make interim reviews and evaluate progress of work based on approved schedule. Frequency of such reviews will be as decided by Departmental Representative. Address and take corrective measures on items identified by reviews and as directed by Departmental Representative. Update schedule accordingly.

.12 In every instance, change or deviation from the Work Schedule, no matter how minimal the risk or impact on safety or inconvenience to tenant or public might appear, will be subject to prior review and approval by the Departmental Representative.

1.3 PROJECT PHASING

.1 Be aware that Facility and tenants must be kept operational for the full duration of work of this contract. Building services to areas under use by tenants must also be maintained at all times during the Facility's operational hours and as specifically defined in operational restrictions specified in this section.

.2 Perform Work of this contract in individual phases in the following sequence:

.1 Perform new structural roof reinforcing work in Mechanical Penthouse. Remove redundant services and equipment and temporarily relocate existing mechanical and electrical services to allow Laboratories to remain in operation during structural renovations.

.2 Install new Lab Exhaust plenum and new Roof-Mounted Fume Hood Exhaust Fans FF-1 and FF-2. Commission new Fume Hood Exhaust plenum and new Fume Hood Fans.

.3 Install new General Exhaust Fan GE-1 and make modifications to General Exhaust Plenum. Commission new GE-1 fan and place in service. GE-1 modifications and fan install and commissioning must be done over a weekend, so that General Exhaust System will be operational by 7:00am Monday morning to service operating Laboratories.

.4 Install and commission New DDC Laboratory Control System infrastructure to control FF-1, FF-2, GE-1, and control back-bone to allow individual Labs to be added to the EMCS as they are renovated and put back in operation.

.5 Commence installation of new DDC Control System for Supply Air Units 5A & 5B prior to starting individual Laboratory HVAC renovations. New DDC Controls for Supply Air Units must be operational before the first individual lab retrofits are complete.

.6 Replace existing fan motors for supply fans 5A & 5B and return fans RF-5A & RF-5B. Install new VFD drives for new fan motors. This work must be done at night or on weekends.

.7 Once fans FF-1, FF-2, and GE-1 are commissioned, commence the process of renovating individual Laboratory ventilation, exhaust, and control systems. Only two(2) Laboratories may be taken out of service at a time. Each individual lab cannot be out of service for more than three(3) weeks. Individual Lab controls, ventilation, general exhaust, fume hood exhaust retrofits, commissioning, testing and balancing must be completed in three(3) weeks, so that the Laboratory can be fully operational at the end of the three(3) week period. Scheduling of all Laboratory down-time must be coordinated with and approved by the Departmental Representative.

.8 During Laboratory shutdown, disconnect existing fume hoods and cap and isolate all services feeding fume hoods. Replace fume hoods with new fume hoods as noted on the drawings, and re-connect all existing services to new fume hoods.

.9 Existing individual redundant Lab Fume Hood Fans and General Exhaust Fans must be disconnected and removed as each Lab is renovated. Extend ductwork as required and connect existing fume hood ducts to new Fume Hood Exhaust Plenum. Extend ductwork as required and connect existing General Exhaust ducts to new/revised General Exhaust Plenum serving GE-1. Cap and drain existing ducts penetrating the roof until final demolition of redundant roof penetrations and roof repair can be scheduled.

.10 All existing fume hood exhaust ductwork, fans, and equipment serving existing the Perchloric Fume Hoods must be removed. This includes removal of the Perchloric Fume Hoods. All Perchloric Fume Hood equipment, ductwork, and fans must be cleaned and inspected using specialized cleaning procedures prior to removal.

.11 All existing Fume Hood Exhaust ductwork must be cleaned and tested prior to removal or prior to connection to new fume hood ductwork.

.12 Carry out additional mechanical, electrical, and control work in mechanical chases, Basement Mechanical Room, and in the Penthouse as work progresses in individual Laboratories.

.13 Remove all existing redundant ductwork, terminal units, fans, equipment, and controls. Dispose of all redundant materials unless directed otherwise by Departmental Representative.

.14 Once all of the ventilation and electrical work is complete in the Mechanical Penthouse, remove all existing redundant roof penetrations and patch roof openings using a qualified roofer.

.15 TAB and final EMCS start-up and testing.

.16 Perform final cleaning of all spaces affected by construction process.

.17 Perform Final Commissioning and Functional Performance Testing as detailed in Section 23 05 04.

.3 Unless indicated or approved otherwise, complete all work of a particular phase prior to commencement of another phase. Obtain Departmental Representative's permission prior to moving between phases.

1.4 OPERATIONAL RESTRICTIONS

.1 The Contractor must recognize that building occupants will be affected by implementation of this Contract. The Contractor must perform the work with utmost regard to the safety and convenience of building occupants and users. All work activities must be planned and scheduled with this in mind. The Contractor will not be permitted to disturb any portion of the building without providing temporary facilities as necessary to ensure safe and direct passage through disturbed or otherwise affected areas.

.2 Contractor to meet with the Departmental Representative on a weekly basis to identify intended work areas, activities and scheduling for the coming week.

.3 To assure that construction work may proceed productively without risk to safety of building occupants and the public, and due to the nature of the tenant's operation be aware that certain work of this contract must be carried out during "Off-Hours". AAFC will endeavor to accommodate contractor when possible to avoid excessive off-hours work.

.4 Off Hours: means a period of time which is outside the daily operational hours of the tenants of the Facility. For the purposes of this contract, Off-Hours are defined as follows:

.1 Weeknight Off-Hours: between the hours of 19:00 and 07:00 for each weekday Monday to Thursday inclusive.

.2 Weekend Off-Hours: between the hours of 19:00 Friday evening to 07:00 Monday morning.

.3 Dependent on the nature and location of the construction activity and due to an unanticipated operational requirement of the Tenant, certain off-hour periods may be redefined by adjusting the start and end time periods or cancellation of a specific off-hour workshift during the course of the Work.

.5 The following work shall be performed during Off-Hours:

- .1 Erection and dismantling of dust barriers, hoarding or other protective devices to separate areas of Facility occupied and under use by public and tenants from work areas;
- .2 Asbestos abatement;
- .3 Demolition of any masonry or concrete inside building;
- .4 All work involving saw cutting or boring of openings through masonry and concrete walls, floors, ceilings or roof that create excessive noise
- .5 Work which requires the use of products controlled by WHMIS and for which MSDS sheets indicate toxic or hazardous materials requiring special handling and application procedures;
- .6 Use of materials having high solvent content or other content emitting strong noxious fumes or odours;
- .7 Cleaning and preparing of occupied areas for daytime use by tenants immediately following an off-hour workshift;
- .8 Work within a tenant occupied area including corridors, stairwells and other circulation routes under use;
- .9 Work which requires the temporary disconnection of power and communication services to occupied areas;
- .10 Testing of fire alarms and other emergency annunciating system;
- .11 Delivery of materials and equipment from exterior to the interior of building when access routes are located in tenant occupied spaces and tenant work will be interrupted.
- .12 Work which creates excessive noise or vibration creating interference with tenant operations.

.6 Departmental Representative reserves the right to stop certain daytime work activities, if the nature of that activity generates excessive noise or dust and have Contractor re-schedule that particular work to be performed during the Off-Hour period.

.7 Ensure that all trades are aware of the "Off-Hour" requirements of this Contract and ensure that any extra costs incurred as a result is included in the Contractor's bid amount for the work. No extra cost will be paid due to failure by General Contractor or his sub-contractors to recognize the off-hour requirements and other restrictions specified herein and to include all necessary allowances within their bids.

.8 Limited Maneuvering Space on Site to areas as defined by Project Manager.

.9 Facility circulation maintained:

- .1 Ensure that entrances, corridors, stairwells, fire exits and other circulation routes are maintained free and clear providing safe and uninterrupted passage for Facility users and public at all times during the entire work.
- .2 Maintain those areas clean and free of construction materials and equipment. Provide temporary dust barriers and other suitable enclosures to ensure users are not exposed to construction activities and are protected from exposure to dust, noise and hazardous conditions.

.3 Provide temporary corridors, walkways, passageways, access to offices, etc. when required due to nature of work. Such circulation routes must be constructed to barrier free requirements unless approved otherwise by Departmental Representative.

.4 Maintain fire escape routes accessible and fire fighting access open all times for the duration of the project.

.5 Do not under any circumstances block fire exit doors. Do not leave construction materials or debris in corridors, stairwells building entrances and exits.

.10 .11 Safety Signage:

.1 Provide on site, and erect as required during progress of work, proper bilingual signage, mounted on self-supporting stands, warning the public and building occupants of construction activities in progress and alerting need to exercise caution in proceeding through disturbed areas of the facility, and directing building occupants through any detours which may be required.

.2 Signage to be professionally printed and mounted on wooden backing, coloured and to express messages as directed by the Departmental Representative.

.3 Generally maximum size of sign should be in the order of 1.0 square meters. Number of signs required will be dependent on number of areas in facility under renovation at any one time.

.4 Include costs for the supply and installation of these signs in the bid amount.

.11 Dust and Dirt Control:

.1 See section 01 50 00 and 01 74 11 for dust control and cleaning requirements.

.2 Effectively plan and implement dust control measures and cleaning activities as an integral part of all construction activities. Review all measures with the Departmental Representative before undertaking work, especially for major dust generating activities.

.3 Do not allow demolition debris and construction waste to accumulate on site and contribute to the propagation of dust.

.4 As work progresses, maintain construction areas in a tidy condition at all times. Remove gross dust accumulations by cleaning and vacuuming immediately following the completion of any major dust generating activity.

.5 Immediately remove all debris and dust from within occupied areas as generated by work therein during a given workshift.

.6 Disconnect and seal-off ductwork of HVAC servicing the construction area to stop spread of dust into other areas of Facility.

.7 Avoid situations and practices which results in dust and dirt being brought from the construction areas or from the exterior and tracked inside the building into occupied areas used by tenants and the public.

.8 Stop workers with soiled footwear from entering building. This includes roofing mechanics and heavy civil workers.

.9 Inform workers and make them sensitive to the need for dust and dirt control. Stringently enforce rules and regulations, immediately address non-compliance.

.10 Keep access doors to work areas closed at all times. Use only designated doors for entry or eggress.

.12 Work in Occupied Areas:
- .1 Where work must be carried out in an occupied area beyond the boundaries of the enclosed construction site, perform such work during the non-operational off-hour periods of the Facility.
- .2 Ensure that all dust, dirt, debris, construction waste, materials, tools and equipment are completely removed at the end of each "off-hour" workshift. Clean and reinstate area ready for daytime use by tenant.
- .3 Provide temporary dust barriers around immediate work areas and place fabric drop sheets over workstations, equipment and other furnishings located immediately adjacent to such work.
- .4 Conduct work in such a way as to minimize the creation of dust and to avoid contaminating areas beyond the immediate location.
- .5 Discuss and obtain Departmental Representative's approval beforehand on the type and extent of dust barriers, protective devices and measures needed.
- .6 Be responsible for temporarily moving office furnishings, workstations, computer equipment and other objects as needed to gain access and conduct work. Reinstall all dislocated items at end of each workshift making the area operational again.
- .7 Disconnect and reconnect any power and communications systems feeding workstations as required.
- .8 Clean such areas as well as those corridors and routes used to gain entry and access.

.13 Cleaning of tenant occupied areas used by Contractor:
- .1 Clean lobbies, corridors, stairs and other circulation routes used by workers to gain access to work by conducting cleaning, vacuuming and washing of floors, walls and other soiled surfaces.
- .2 Obtain and pay for the services of a professional cleaning company to perform this cleaning.
- .3 Meager attempts at controlling dust and ineffective unprofessional cleaning procedures will not be tolerated.
- .4 Failure to provide effective dust control, allowing construction dust and dirt to escape beyond construction areas and contaminate occupied areas and building circulation areas will result in Contractor being ordered to immediately provide professional cleaning services without delay to remedy the situation and conduct all cleaning to the extent as determined by Departmental Representative. Alternatively, Departmental Representative may, at certain times and at own discretion, obtain the services of an independent building cleaning agency when cleaning being provided by Contractor is ineffective or tardy in response. Costs of such services will be charged against Contractor in the form of financial penalties or holdback assessments against the Contract.

.14 Ensure that all sub-trades are made aware of and abide by the contents of this section and in particularly the work restrictions specified herein due to tenant operational requirements.

1.5 PROJECT MEETINGS

.1 Schedule and administer project meetings, held on a minimum bi-weekly basis, for entire duration of work and more often when directed by Departmental Representative as deemed necessary due to progress of work or particular situation.

.2 Contractor to prepare agenda for meetings.

.3 Notify participants in writing 4 days in advance of meeting date.
  - .1 Ensure attendance of all subcontractors.
  - .2 Departmental Representative will provide list of other attendees to be notified.

.4 Hold meetings at project site or where approved by Departmental Representative.

.5 Contractor to preside at meetings and record minutes.
  - .1 Indicate significant proceedings and decisions. Identify action items by parties.
  - .2 Distribute to participants by mail or by facsimile within 3 calendar days after each meeting.
  - .3 Make revisions as directed by Departmental Representative.
  - .4 Departmental Representative will advise whether submission of minutes by Email is acceptable. Decision will be based on compatibility of software among participants.

1.6 WORK COORDINATION

.1 Mechanical Contractor is responsible for coordinating the work of the various trades and predetermining where the work of such trades interfaces with each other.
  - .1 Designate one person from own employ having overall responsibility to review contract documents and shop drawings, plan and manage such coordination.

.2 Mechanical Contractor shall convene meetings between trades whose work interfaces and ensure that they are fully aware of the areas and the extent of where interfacing is required.
  - .1 Provide each trade with the plans and specs of the interfacing trade, as required, to assist them in planning and carrying out their respective work.
  - .2 Develop coordination drawings when deemed required illustrating potential interference between work of various trades and distribute to all affected parties including structural trade.
    - .1 Pay particularly close attention to overhead work above ceilings and within or near to building structural elements.
    - .2 Coordination drawings to identify all building elements, services lines, rough-in points and indicate from where various services are coming.
  - .3 Review coordination drawings at purposely called meetings. Have subcontractors sign-off on drawings and publish minutes of each meeting.
  - .4 Plan and coordinate work in such a way to minimize quantity of service line offsets.
  - .5 Submit copy of coordination drawings and meeting minutes to Departmental Representative for information purposes.

.3 Submission of shop drawings and ordering of prefabricated equipment or prebuilt components shall only occur once coordination meeting for such items has taken place between trades and all conditions affecting the work of the interfacing trades has been made known and accounted for.

.4 Work Cooperation:
 .1 Ensure cooperation between trades in order to facilitate the general progress of the work and avoid situations of spatial interference.
 .2 Ensure that each trade provides all other trades reasonable opportunity for the completion of the work and in such a way as to prevent unnecessary delays, cutting, patching and the need to remove and replace completed work.

.5 No extra costs to the Contract will be considered by the Departmental Representative as a result of Contractor's failure to effectively coordinate all portions of the Work. Disputes between the various trades as a result of their not being informed of the areas and extent of interface work shall be the sole responsibility of the General Contractor to be resolved at own cost.

1.7 RECORDS OF CONSTRUCTION

.1 Refer to Section 01 78 00 – Closeout Submittals.

1.8 INSPECTION COOPERATION

.1 Cooperate with Departmental representative on inspection of work.

.2 Provide assistance when requested and any necessary equipment required.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 The Lump Sum prices are full compensation for the work necessary to complete each item in the Contract in the Form of Tender. The prices bid are complete and separate form other or related bid items.

.2 In the case of a conflict between the instructions for measurement and payment contained in Section 01 22 00 and another Section of the Specifications, the requirements of Section 0122 00 shall govern.

.3 No separate payment will be made for:

- .1 Unauthorized work beyond the limits shown.
- .2 Contractor’s specified Quality Control testing.
- .3 Layout of work.

1.2 LUMP SUM WORK

.1 The tendered price lump sum work includes all items listed within the specification and drawings. Price includes all labour, materials and equipment for complete supply and installation of the work.

.2 Mobilization/Demolition including all equipment, temporary facilities, security, maintenance, and cleaning of site, secure all necessary regulatory permits, insurance and bonding, establishing health and safety protocol.

.3 All demolition, material disconnection/reconnection, site excavation, construction, building renovation, repairs and improvements and site restoration and landscaping, as contained in the specification.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

1.1 RELATED SECTIONS

.1 Section 01 78 00: Closeout Submittals.

.2 Section 0174 21 Construction/Demolition Waste Management and Disposal.

1.2 SUBMITTAL GENERAL REQUIREMENTS

.1 Submit to Departmental Representative for review requested submittals specified in various sections of the specifications including shop drawings, samples, permits, compliance certificates, test reports, work management plans and other data required as part of the work.

.2 Submit with reasonable promptness and in orderly sequence so as to allow for Departmental Representative's review and not cause delay in Work. Failure to submit in ample time will not be considered sufficient reason for an extension of Contract time and no claim for extension by reason of such default will be allowed.

.3 Do not proceed with work until relevant submissions have been reviewed.

.4 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.5 Where items or information is not produced in SI Metric units, provide soft converted values.

.6 Review submittals prior to submission. Ensure that necessary requirements have been determined and verified and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents.
.1 Submittals not stamped, signed, dated and identified as to specific project will be returned unexamined by Departmental Representative and considered rejected.

.7 Verify field measurements and affected adjacent Work are coordinated.

.8 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.9 Contractor's responsibility for errors, ommissions or deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative's review.

.10 Submittal format:
   .1 Submit paper originals, or alternatively clear and fully ledgible photocopies of originals. Facsimiles are not acceptable, except in special circumstances pre-approved by Departmental Representative. Poorly printed non-legible photocopies or facsimiles will not be accepted and be returned for resubmission.

.11 Make changes or revision to submissions which Departmental Representative may require, consistent with Contract Documents and resubmit as directed by Departmental Representative. When resubmitting, identify in writing of any revisions other than those requested.

.12 Keep one reviewed copy of each submittal document on site for duration of Work.

1.3 ACTION AND INFORMATION SUBMITTALS

.1 Prepare and submit the following prior to project start-up:

.1 Submit 3 copies of Environmental Protection Plan.

.2 Refer to Section 01 35 43 – Environmental Procedures for the requirements of the Environmental Protection Plan.

.2 Submit 3 copies of Site-Specific Health and Safety Plan.

.1 Refer to Section 01 35 29 – Health and Safety Requirements for the requirements of the Site-Specific Health and Safety Plan.

.3 Prepare and submit the following prior to notification to Departmental Representative of Substantial Completion.

1.4 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic copy colour digital photography in jpg format, standard resolution as directed by Departmental Representative.

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

.3 Number of viewpoints:

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

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

.1 Upon completion of: of Work, and as directed by Departmental Representative.

1.5 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means fabrication drawings, erection drawings, diagrams, illustrations, schedules, performance charts, technical product data, brochures, specifications, test reports installation instructions and other data which are to be provided by Contractor to illustrate compliance with specified materials and details of a portion of work.

.2 Shop Drawing Submittal Schedule:
.1 Submit within 10 working days of acceptance of bid a schedule listing all shop drawings to be submitted for project.
.2 Schedule shall be in format acceptable to Departmental Representative and indicate proposed submission date for each item, status of review and anticipated product delivery date to site. Track all submissions for entire project.
.3 Revise schedule as work progresses. Identify items which have been reviewed and finalized and indicating those outstanding.
.4 Update schedule at stipulated dates or project time intervals predetermined and agreed upon with Departmental Representative at commencement of Work.

.3 Shop Drawing Quantities: submit sufficient copies required by the General Contractor and sub-contractors plus 3 copies which will be retained by Departmental Representative.
.1 Ensure sufficient copies are submitted to enable one complete set to be included in each of the maintenance manuals specified in 01 78 00.
.2 Acceptable alternate: PDF format.

.4 Shop Drawings Format:
.1 Opaque white prints or photocopies of original drawings or standard drawings modified to clearly illustrate work specific to project requirements. Maximum sheet size to be 1000 x 707 mm.
.2 Product Data from manufacturer's standard catalogue sheets, brochures, literature, performance charts and diagrams, used to illustrate standard manufactured products, to be original full colour brochures, clearly marked indicating applicable data and deleting information not applicable to project.
.3 Non or poorly legible drawings, photocopies or facsimiles will not be accepted and returned not reviewed.
.4 Acceptable alternate: PDF format.

.5 Shop Drawings Content:
.1 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where items or equipment attach or connect to other items or equipment, confirm that all interrelated work have been coordinated, regardless of section or trade from which the adjacent work is being supplied and installed.
.2 Supplement manufacturer's standard drawings and literature with additional information to provide details applicable to project.
.3 Delete information not applicable to project on all submittals.
.4 Equipment installation/start-up data: include manufacturer's recommended installation instructions, pre-start and start-up checklists for those pieces of equipment and systems designated to be commissioned as specified in each section.

.6 Allow 14 calendar days for Departmental Representative's review of each submission.

.7 Adjustments or corrections made on shop drawings by Departmental Representative are not intended to change Contract Amount. If adjustments affect value of Work, advise Departmental Representative in writing prior to proceeding with Work.

.8 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections and comments are made, fabrication and installation may proceed upon receipt of shop drawings. If shop drawings are rejected and noted to be Resubmitted, do not proceed with that portion of work until resubmission and review of corrected shop drawings, through same submission procedures indicated above.

.9 Be advised that costs and expenses incurred by Departmental Representative to conduct more than one review of incorrectly prepared shop drawing submittal for a particular material, equipment or component of work may be assessed against the Contractor in the form of a financial holdback to the Contract.

.10 Accompany each submissions with transmittal letter, in duplicate, containing:
- .1 Date.
- .2 Project title and project number.
- .3 Contractor's name and address.
- .4 Identification and quantity of each shop drawing, product data and sample.
- .5 Other pertinent data.

.11 Submissions shall include:
- .1 Date and revision dates.
- .2 Project title and project 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 Cross references to particular details of contract drawings and specifications section number for which shop drawing submission addresses.
- .6 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.

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

.13 The review of shop drawings by the Departmental Representative or by an authorized Consultant or designate is for sole purpose of ascertaining conformance with general concept. This review shall not mean that Canada approves the detail design inherent in the 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 all requirements of the construction and Contract Documents. 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 all sub-trades.

1.6 SAMPLES

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

.2 Deliver samples to Departmental Representative's office or to other address as directed. Do not drop off samples at construction site except for pre-approved circumstances previously approved by Departmental Representative.

.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 Amount. If adjustments will result in a cost increase to the Contract notify Departmental Representative in writing 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.

END OF SECTION

1.1 SECTION INCLUDES

.1 Fire Safety Requirements.

.2 Hot Work Permit.

.3 Existing Fire Protection and Alarm Systems.

1.2 RELATED SECTIONS

.1 Section 01 35 29: Health and Safety Requirements.

1.3 REFERENCES

.1 Fire Protection Standards issued by Fire Protection Services, Labour Program Division of Service Canada:
  .1 FCC No. 301-June 1982 Standard for Construction Operations.
  .2 FCC No. 302-June 1982 Standard for Welding and Cutting.

.2 FCC standards may be viewed at: http://www.hrsdc.gc.ca/eng/labour/fire_ protection /policies_standards/commissioner/inde .shtml
  .1 Fire Protection Services - Atlantic Region office, Halifax, N.S, Tel. 902-426-6053.

1.4 DEFINITIONS

.1 Hot Work defined as:
  .1 Welding work.
  .2 Cutting of materials by use of torch or other open flame devices.
  .3 Grinding with equipment which produces sparks.
  .4 Use of open flame torches such as for roofing work.

1.5 SUBMITTALS

.1 Submit copy of Hot Work Procedures and sample of Hot Work permit to Departmental Representative for review, within 14 calendar days of acceptance of bid.

.2 Submit in accordance with section 01 33 00.

1.6 FIRE SAFETY REQUIREMENTS

.1 Implement and follow fire safety measures during Work. Comply with following:
  .1 National Fire Code.
  .2 Fire Protection Standards FCC 301 and FCC 302.
  .3 Federal and Provincial Occupational Health and Safety Acts and Regulations.

.2 In event of conflict between any provisions of above authorities the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, Departmental Representative will advise on the course of action to be followed.

1.7 HOT WORK AUTHORIZATION

.1 Obtain Departmental Representative's written "Authorization to Proceed" before conducting any form of Hot Work on site.

.2 To obtain authorization submit to Departmental Representative:
- .1 Contractor's typewritten Hot Work Procedures to be followed on site as specified below.
- .2 Description of the type and frequency of Hot Work required.
- .3 Sample Hot Work Permit to be used.

.3 Upon review and confirmation that effective fire safety measures will be implemented and followed during performance of hot work, Departmental Representative will give authorization to proceed as follows:
- .1 Issue one written "Authorization to Proceed" covering the entire project for duration of work or;
- .2 Subdivide the work into pre-determined, individual activities, each activity requiring a separately written authorization to proceed.

.4 Requirement for individual authorization will be based on:
- .1 Nature or phasing of work;
- .2 Risk to Facility operations;
- .3 Quantity of various trades needing to perform hot work on project or;
- .4 Other situation deemed necessary by Departmental Representative to ensure fire safety on premises.

.5 Do not perform any Hot Work until receipt of Departmental Representative's written "Authorization to Proceed" for that portion of work.

.6 In tenant occupied Facility, coordinate performance of Hot Work with Facility Manager through the Departmental Representative. When directed, perform Hot Work only during non-operative hours of the Facility. Follow Departmental Representative's directives in this regard.

1.8 HOT WORK PROCEDURES

.1 Develop and implement safety procedures and work practises to be followed during the performance of Hot Work.

.2 Hot Work Procedures to include:
- .1 Requirement to perform hazard assessment of site and immediate work area beforehand for each hot work event in accordance with Safety Plan specified in section 01 35 29.

.2 Use of a Hot Work Permit system with individually issued permit by Contractor's Superintendent to worker or subcontractor granting permission to proceed with Hot Work.
.3 Permit required for each Hot Work event.
.4 Designation of a person on site as a Fire Safety Watcher responsible to conduct a fire safety watch for a minimum duration of 60 minutes immediately following the completion of the Hot Work.
.5 Compliance with fire safety codes, standards and occupational health and safety regulations specified.
.6 Site specific rules and procedures in force at the site as provided by the Facility Manager.

.3 Generic procedures, if used, must be edited and supplemented with pertinent information tailored to reflect specific project conditions. Label document as being the Hot Work Procedures for this contract.

.4 Procedures shall clearly establish responsibilities of:
.1 Worker performing hot work,
.2 Person issuing the Hot Work Permit,
.3 Fire Safety Watcher,
.4 Subcontractor(s) and Contractor.

.5 Brief all workers and subcontractors on Hot Work Procedures and of Permit system. Stringently enforce compliance.

1.9 HOT WORK PERMIT

.1 Hot Work Permit to include the following:
.1 Project name and project number;
.2 Building name and specific room or area where hot work will be performed;
.3 Date of issue;
.4 Description of hot work type needed;
.5 Special precautions to be followed, including type of fire extinguisher needed;
.6 Name and signature of permit issuer.
.7 Name of worker to which the permit is issued.
.8 Permit validity period not to exceed 8 hours. Indicate start time/date and termination time/date.
.9 Worker's signature with time/date of hot work completion.
.10 Stipulated time period of safety watch.
.11 Fire Safety Wather's signature with time/date.

.2 Permit to be typewritten form. Industry Standard forms shall only be used if all data specified above is included on form.

.3 Each Hot Work Permit to be completed in full, signed and returned to Contractor's Superintendent for safe keeping on site.

1.10 FIRE PROTECTION AND ALARM SYSTEMS

.1 Fire protection and alarm systems shall not be:
  .1 Obstructed.
  .2 Shut-off, unless approved by Departmental Representative.
  .3 Left inactive at the end of a working day or shift.

.2 Do not use fire hydrants, standpipes and hose systems for purposes other than fire fighting.

.3 Costs incurred, from the fire department, Facility owner and tenants, resulting from negligently setting off false alarms will be charged to the Contractor in the form of financial progress payment reductions and holdback assessments against the Contract.

1.11 DOCUMENTS ON SITE

.1 Keep Hot Work Permits and Hazard assessment documentation on site for duration of Work.

.2 Upon request, make available to Departmental Representative or to authorized safety Representative for inspection.

END OF SECTION

1.1 SECTION INCLUDES

.1 Procedures to isolate and lockout electrical facility and other equipment from energy sources.

1.2 RELATED SECTIONS

.1 Section 01 35 29: Health and Safety

1.3 REFERENCES

.1 CSA C22.1-12, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 CAN/CSA-C22.3 No.1-06, Overhead Systems.

.3 CSA C22.3 No.7-06, Underground Systems.

.4 COSH: Canada Occupational Health and Safety Regulations made under Part II of the Canada Labour Code.

1.4 DEFINITIONS

.1 Electrical Facility: means any system, equipment, device, apparatus, wiring, conductor, assembly or part thereof that is used for the generation, transformation, transmission, distribution, storage, control, measurement or utilization of electrical energy, and that has an amperage and voltage that is dangerous to persons.

.2 Guarantee of Isolation: means a guarantee by a competent person in control or in charge that a particular facility or equipment has been isolated.

.3 De-energize: in the electrical sense, that a piece of equipment is isolated and grounded, e.g. if the equipment is not grounded, it cannot be considered de-energized (DEAD).

.4 Guarded: means that an equipment or facility is covered, shielded, fenced, enclosed, inaccessible by location, or otherwise protected in a manner that, to the extent that is reasonably practicable, will prevent or reduce danger to any person who might touch or go near such item.

.5 Isolate: means that an electrical facility, mechanical equipment or machinery is separated or disconnected from every source of electrical, mechanical, hydraulic, pneumatic or other kind of energy that is capable of making it dangerous.

.6 Live/alive: means that an electrical facility produces, contains, stores or is electrically connected to a source of alternating or direct current of an amperage and voltage that is dangerous or contains any hydraulic, pneumatic or other kind of energy that is capable of making the facility dangerous to persons.

1.5 COMPLIANCE REQUIREMENTS

.1 Comply with the following in regards to isolation and lockout of electrical facilities and equipment:
- .1 Canadian Electrical Code.
- .2 Federal and Provincial Occupational Health and Safety Acts and Regulations.
- .3 Regulations and code of practise as applicable to mechnical equipment or other machinery being de-energized.
- .4 Procedures specified herein.

.2 In event of conflict between any provisions of above authorities the most stringent provision will apply.

1.6 SUBMITTALS

.1 Submit copy of lockout procedures, sample of lockout permit and lockout tags proposed for use in accordance with Section 01 33 00. Submit within 14 calendar days of acceptance of bid.

1.7 ISOLATION OF EXISTING SERVICES

.1 Obtain Departmental Representative's written authorization prior to working on existing live or active electrical facilities and equipment and before proceeding with isolation of such item.

.2 To obtain authorization, submit to Departmental Representative the following documentation:
- .1 Written request to isolate the particular service or facility and;
- .2 Copy of Contractor's Lockout Procedures.

.3 Make a Request for Isolation for each event, unless directed otherwise by Departmental Representative, as follows:
- .1 Fill-out standard form in current use at the Facility as provided by Departmental Representative or;
- .2 Where no form exist, make written request indicating:
  - .1 The equipment, system or service to be isolated and it's location;
  - .2 Duration of isolation period (ie: start time & date and completion time & date).
  - .3 Voltage of service feed to system or equipment being isolated.
  - .4 Name of person making the request.

.4 Do not proceed with isolation until receipt of written notification from Departmental Representative granting the Isolation Request and authorization to proceed with the work.
- .1 Note that Departmental Representative may designate another person at the Facility being authorized to grant the Isolation Request.

.5 Conduct safe, orderly shut down of equipment or facility. De-energize, isolate and lockout power and other sources of energy feeding the equipment or facility.

.6 Determine in advance, as much as possible, in cooperation with the Departmental Representative, the type and frequency of situations which will require isolation of existing services.

.7 Plan and schedule shut down of existing services in consultation with the Departmental Representative and the Facility Manager. Minimize impact and downtime of Facility operations. Follow Departmental Representative's directives in this regard.

.8 Conduct hazard assessment as part of the process in accordance with health and safety requirements specified Section 01 35 29.

1.8 LOCKOUTS

.1 De-energize, isolate and lockout electrical facility, mechanical equipment and machinery from all potential sources of energy prior to working on such items.

.2 Develop and implement clear and specific lockout procedures to be followed as part of the Work.

.3 Prepare typed written Lockout Procedures describing safe work practices, procedures, worker responsibilities and sequence of activities to be followed on site by workforce to safely isolate an active piece of equipment or electrical facility and effectively lockout and tagout it's sources of energy.

.4 Include as part of the Lockout Procedures a system of lockout permits managed by Contractor's Superintendent or other qualified person designated by him/her as being "in-charge" at the site.
  - .1 A lockout permit shall be issued to specific worker providing a Guarantee of Isolation before each event when work must be performed on a live equipment or electrical facility.
  - .2 Duties of person managing the permit system to include:
    - .1 Issuance of permits and lockout tags to workers.
    - .2 Determining permit duration.
    - .3 Maintaining record of permits and tags issued.
    - .4 Making a Request for Isolation to Departmental Representative when required as specified above.
    - .5 Designating a Safety Watcher, when one is required based on type of work.
    - .6 Ensuring equipment or facility has been properly isolated.
    - .7 Collecting and safekeeping lockout tags returned by workers as a record of the event.

.5 Clearly establish, describe and allocate responsibilities of:
  - .1 Workers.
  - .2 Person managing the lockout permit system.
  - .3 Safety Watcher.
  - .4 Subcontractor(s) and General Contractor.

.6 Generic procedures, if used, must be edited and supplemented with pertinent information to reflect specific project requirements.
  - .1 Incorporate site specific rules and procedures in force at site as provided by Facility Manager through the Departmental Representative.
  - .2 Clearly label the document as being the Lockout procedures applicable to work of this contract.

.7 Use energy isolation lockout devices specifically designed and appropriate for type of facility or equipment being locked out.

.8 Use industry standard lockout tags.

.9 Provide appropriate safety grounding and guards as required.

1.9 CONFORMANCE

.1 Brief all workers and subcontractors on requirements of this section. Stringently enforce use and compliance.

1.10 DOCUMENTS ON SITE

.1 Post Lockout Procedures on site in common location for viewing by workers.

.2 Keep copies of Request for Isolation forms and lockout permits and tags issued to workers on site for full duration of Work.

.3 Upon request, make available to Departmental Representative or to authorized safety representative for inspection.

END OF SECTION

1.1 RELATED SECTIONS

.1 Section 01 35 24: Special Procedures on Fire Safety Requirements.

.2 Section 01 35 25: Special Procedures on Lockout Requirements.

1.2 DEFINITIONS

.1 COSH: Canada Occupational Health and Safety Regulations made under Part II of the Canada Labour Code.

.2 Competent Person: means a person who is:
- .1 Qualified by virtue of personal knowledge, training and experience to perform assigned work in a manner that will ensure the health and safety of persons in the workplace, and;
- .2 Knowledgeable about the provisions of occupational health and safety statutes and regulations that apply to the Work and;
- .3 Knowledgeable about potential or actual danger to health or safety associated with the Work.

.3 Medical Aid Injury: any minor injury for which medical treatment was provided and the cost of which is covered by Workers' Compensation Board of the province in which the injury was incurred.

.4 PPE: personal protective equipment.

.5 Work Site: where used in this section shall mean areas, located at the premises where Work is undertaken, used by Contractor to perform all of the activities associated with the performance of the Work.

1.3 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00.

.2 Submit site-specific Health and Safety Plan prior to commencement of Work.
- .1 Submit within 10 work days of notification of Bid Acceptance. Provide 3 copies.
- .2 Departmental Representative will review Health and Safety Plan and provide comments.
- .3 Revise the Plan as appropriate and resubmit within 10 work days after receipt of comments.
- .4 Departmental Representative's review and comments made of the Plan shall not be construed as an endorsement, approval or implied warranty of any kind by Canada and does not reduce Contractor's overall responsibility for Occupational Health and Safety of the Work.
- .5 Submit revisions and updates made to the Plan during the course of Work.

.3 Submit name of designated Health and Safety Site Representative and support documentation specified in the Safety Plan.

.4 Submit building permit, compliance certificates and other permits obtained.

.5 Submit copy of Letter in Good Standing from Provincial Workers Compensation or other department of labour organization.
  .1 Submit update of Letter of Good Standing whenever expiration date occurs during the period of Work.

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

.7 Submit copies of incident reports.

.8 Submit WHMIS MSDS - Material Safety Data Sheets.

1.4 COMPLIANCE REQUIREMENTS

.1 Comply with Occupational Health and Safety Act for Province of Nova Scotia, and Regulations made pursuant to the Act.

.5 Comply with Canada Labour Code - Part II (entitled Occupational Health and Safety) and the Canada Occupational Health and Safety Regulations as well as any other regulations made pursuant to the Act.
  .1 The Canada Labour Code can be viewed at: www.http://laws-lois.justice.gc.ca/eng/acts/L-2 fulltext.html.
  .2 Canadian Occupational Health and Safety Regulations can be viewed at: http://laws-lois. justice.gc.ca/eng/regulations/SOR-86-304/ index.html.
  .3 A copy may be obtained at: Canadian Government Publishing Public Works & Government Services Canada Ottawa, Ontario, K1A 0S9 Tel: 819-956-4800 or 1-800-635-7943 Publication No. L31-85/2000 F.

.6 Treasury Board of Canada Secretariat (TBS):
  .1 Treasury Board, Fire Protection Standard April 1, 2010 www.tbs-sct.gc.ca/pol/doc-eng.aspx ?id=17316&section=text.

.7 Canadian Standards Association (CSA):
  .1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

.8 Observe construction safety measures of:
  .1 NBC 2010, Division B, Part 8.
  .2 Municipal by-laws and ordinances.

.9 In case of conflict or discrepancy between above specified requirements, the more stringent shall apply.

.10 Maintain Workers Compensation Coverage in good standing for duration of Contract. Provide proof of clearance through submission of Letter in Good Standing.

.11 Medical Surveillance: Where prescribed by legislation or regulation, obtain and maintain worker medical surveillance documentation.

1.5 RESPONSIBILITY

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

.2 Comply with and enforce compliance by all workers, sub-contractors and other persons granted access to Work Site with safety requirements of Contract Documents, applicable federal, provincial, and local by-laws, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.6 SITE CONTROL AND ACCESS

.1 Control the Work and entry points to Work Site. Approve and grant access only to workers and authorized persons. Immediately stop and remove non-authorized persons.
  .1 Departmental Representative will provide names of those persons authorized by Departmental Representative to enter onto Work Site and will ensure that such authorized persons have the required knowledge and training on Health and Safety pertinent to their reason for being at the site, however, Contractor remains responsible for the health and safety of authorized persons while at the Work Site.

.2 Isolate Work Site from other areas of the premises by use of appropriate means.
  .1 Erect fences, hoarding, barricades and temporary lighting as required to effectively delineate the Work Site, stop non-authorized entry, and to protect pedestrians and vehicular traffic around and adjacent to the Work and create a safe environment. See Section 01 50 00 for minimum acceptable requirements.
  .2 Post signage at entry points and other strategic locations indicating restricted access and conditions for access.

  .3 Use professionally made signs with bilingual message in the 2 official languages or international known graphic symbols.

.3 Provide safety orientation session to persons granted access to Work Site. Advise of hazards and safety rules to be observed while on site.

.4 Ensure persons granted site access wear appropriate PPE. Supply PPE to inspection authorities who require access to conduct tests or perform inspections.

.5 Secure Work Site against entry when inactive or unoccupied and to protect persons against harm. Provide security guard where adequate protection cannot be achieved by other means.

1.7 PROTECTION

.1 Give precedence to safety and health of persons and protection of environment over cost and schedule considerations for Work.

.2 Should unforeseen or peculiar safety related hazard or condition become evident during performance of Work, immediately take measures to rectify situation and prevent damage or harm. Advise Departmental Representative verbally and in writing.

1.8 FILING OF NOTICE

.1 File Notice of Project with pertinent provincial health and safety authorities prior to beginning of Work.
  - .1 Departmental Representative will assist in locating address if needed.

1.9 PERMITS

.1 Post permits, licenses and compliance certificates, specified in section 01 10 10, at Work Site.

.2 Where a particular permit or compliance certificate cannot be obtained, notify Departmental Representative in writing and obtain approval to proceed before carrying out applicable portion of work.

1.10 HAZARD ASSESSMENTS

.1 Perform site specific health and safety hazard assessment of the Work and its site.

.2 Carryout initial assessment prior to commencement of Work with further assessments as needed during progress of work, including when new trades and subcontractors arrive on site.

.3 Record results and address in Health and Safety Plan.

.4 Keep documentation on site for entire duration of the Work.

1.11 PROJECT/SITE CONDITIONS

.1 Following are potential health, environmental and safety hazards at the site for which Work may involve contact with:
  - .1 Existing hazardous and controlled products stored on site:
  - .2 Existing hazardous substances or contaminated building materials:
  - .3 Existing Fume Hoods and Fume Hood ductwork, equipment and fans.
  - .4 Existing perchloric Fume Hoods and associated ductwork, fans and equipment.
  - .5 Known latent site and environmental conditions:
  - .6 Facility on-going operations:
  - .7 Existing Lab Plumbing, including waste and gas piping.

.2 Above items shall not be construed as being complete and inclusive of potential health and safety hazards encountered during Work.

.3 Include above items in the hazard assessment of the Work.

.4 MSDS Data sheets of pertinent hazardous and controlled products stored on site can be obtained from Departmental Representative.

1.12 MEETINGS

.1 Attend pre-construction health and safety meeting, convened and chaired by Departmental Representative, prior to commencement of Work, at time, date and location determined by Departmental Representative. Ensure attendance of:
  - .1 Superintendent of Work.
  - .2 Designated Health & Safety Site Representative.
  - .3 Subcontractors.

.2 Conduct regularly scheduled tool box and safety meetings during the Work in conformance with Occupational Health and Safety regulations.

.3 Keep documents on site.

1.13 HEALTH AND SAFETY PLAN

.1 Prior to commencement of Work, develop written Health and Safety Plan specific to the Work. Implement, maintain, and enforce Plan for entire duration of Work and until final demobilization from site.

.2 Health and Safety Plan shall include the following components:
  - .1 List of health risks and safety hazards identified by hazard assessment.
  - .2 Control measures used to mitigate risks and hazards identified.
  - .3 On-site Contingency and Emergency Response Plan as specified below.
  - .4 On-site Communication Plan as specified below.
  - .5 Name of Contractor's designated Health & Safety Site Representative and information showing proof of his/her competence and reporting relationship in Contractor's company.
  - .6 Names, competence and reporting relationship of other supervisory personnel used in the Work for occupational health and safety purposes.

.3 On-site Contingency and Emergency Response Plan shall include:
  - .1 Operational procedures, evacuation measures and communication process to be implemented in the event of an emergency.
  - .2 Evacuation Plan: site and floor plan layouts showing escape routes, marshalling areas. Details on alarm notification methods, fire drills, location of fire fighting equipment and other related data.
  - .3 Name, duties and responsibilities of persons designated as Emergency Warden(s) and deputies.
  - .4 Emergency Contacts: name and telephone number of officials from:
    - .1 General Contractor and subcontractors.

.2 Pertinent Federal and Provincial Departments and Authorities having jurisdiction.
.3 Local emergency resource organizations.
.5 Harmonize Plan with Facility's Emergency Response and Evacuation Plan. Departmental Representative will provide pertinent data including name of PWGSC and Facility Management contacts.

.4 On-site Communication Plan:
.1 Procedures for sharing of work related safety information to workers and subcontractors, including emergency and evacuation measures.
.2 List of critical work activities to be communicated with Facility Manager which have a risk of endangering health and safety of Facility users.

.5 Address all activities of the Work including those of subcontractors.

.6 Review Health and Safety Plan regularly during the Work. Update as conditions warrant to address emerging risks and hazards, such as whenever new trade or subcontractor arrive at Work Site.

.7 Departmental Representative will respond in writing, where deficiencies or concerns are noted and may request re-submission of the Plan with correction of deficiencies or concerns.
.8 Post copy of the Plan, and updates, prominently on Work Site.

1.14 SAFETY SUPERVISION

.1 Employ Health & Safety Site Representative responsible for daily supervision of health and safety of the Work.

.2 Health & Safety Site Representative may be the Superintendent of the Work or other person designated by Contractor and shall be assigned the responsibility and authority to:
.1 Implement, monitor and enforce daily compliance with health and safety requirements of the Work
.2 Monitor and enforce Contractor's site-specific Health and Safety Plan.
.3 Conduct site safety orientation session to persons granted access to Work Site.
.4 Ensure that persons allowed site access are knowledgeable and trained in health and safety pertinent to their activities at the site or are escorted by a competent person while on the Work Site.
.5 Stop the Work as deemed necessary for reasons of health and safety.

.3 Health & Safety Site Representative must:
.1 Be qualified and competent person in occupational health and safety.
.2 Have site-related working experience specific to activities of the Work.
.3 Be on Work Site at all times during execution of the Work.

.4 All supervisory personnel assigned to the Work shall also be competent persons.

.5 Inspections:
  .1 Conduct regularly scheduled safety inspections of the Work on a minimum bi-weekly basis. Record deficiencies and remedial action taken.
  .2 Conduct Formal Inspections on a minimum monthly basis. Use standardized safety inspection forms. Distribute to subcontractors.
  .3 Follow-up and ensure corrective measures are taken.

.6 Cooperate with Facility's Occupational Health and Safety representative should one be designated by Departmental Representative.

.7 Keep inspection reports and supervision related documentation on site.

1.15 TRAINING

.1 Use only skilled workers on Work Site who are effectively trained in occupational health and safety procedures and practices pertinent to their assigned task.

.2 Maintain employee records and evidence of training received. Make data available to Departmental Representative upon request.

.3 When unforeseen or peculiar safety-related 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.

1.16 MINIMUM SITE SAFETY RULES

.1 Notwithstanding requirement to abide by federal and provincial health and safety regulations; ensure the following minimum safety rules are obeyed by persons granted access to Work Site:
  .1 Wear appropriate PPE pertinent to the Work or assigned task; minimum being hard hat, safety footwear, safety glasses and hearing protection.
  .2 Immediately report unsafe condition at site, near-miss accident, injury and damage.
  .3 Maintain site and storage areas in a tidy condition free of hazards causing injury.
  .4 Obey warning signs and safety tags.

.2 Brief persons of disciplinary protocols to be taken for non compliance. Post rules on site.

1.17 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 will stop Work if non-compliance of health and safety regulations is not corrected in a timely manner.

1.18 INCIDENT REPORTING

.1 Investigate and report the following incidents to Departmental Representative:
  - .1 Incidents requiring notification to Provincial Department of Occupational Safety and Health, Workers Compensation Board or to other regulatory Agency.
  - .2 Medical aid injuries.
  - .3 Property damage in excess of $10,000.00,
  - .4 Interruptions to Facility operations resulting in an operational lost to a Federal department in excess of $5,000.00.

.2 Submit report in writing.

1.19 HAZARDOUS PRODUCTS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS).

.2 Keep MSDS data sheets for all products delivered to site.
  - .1 Post on site.
  - .2 Submit copy to Departmental Representative.
  - .3 For interior work in an occupied Facility, post additional copy in one or more publically accessible locations.

1.20 BLASTING

.1 Blasting or other use of explosives is not permitted on site without prior receipt of written permission and instructions from Departmental Representative.

1.21 POWDER ACTUATED DEVICES

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

1.22 CONFINED SPACES

.1 Abide by occupational health and safety regulations regarding work in confined spaces.

.2 Obtain an Entry Permit in accordance with Part XI of the Canada Occupational Health and Safety Regulations for entry into an existing identified confined space located at the Facility or premises of Work.
  - .1 Obtain permit from Facility Manager.
  - .2 Keep copy of permit issued.

.3 Safety for Inspectors:
  - .1 Provide PPE and training to Departmental Representative and other persons who require entry into confined space to perform inspections.
  - .2 Be responsible for efficacy of equipment and safety of persons during their entry and occupancy in the confined space.

1.23 SITE RECORDS

.1 Maintain on Work Site copy of safety related documentation and reports stipulated to be produced in compliance with Acts and Regulations of authorities having jurisdiction and of those documents specified herein.

.2 Upon request, make available to Departmental Representative or authorized Safety Officer for inspection.

1.24 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on Work Site in accordance with Acts and Regulations of Province having jurisdiction.

.2 Post other documents as specified herein, including:
  .1 Site specific Health and Safety Plan.
  .2 WHMIS data sheets.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Waste Management and Disposal: Section 01 74 21.

1.2 DEFINITIONS

.1 Hazardous Material: Product, substance, or organism that is used for its original purpose; and that is either dangerous goods or a material that may cause adverse impact to the environment or adversely affect health of persons, animals, or plant life when released into the environment.

.2 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humans; or degrade environment aesthetically, culturally and/or historically.

.3 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.

.4 Reference Standards:

- .1 U.S. Environmental Protection Agency (EPA)/Office of Water.
  - .1 EPA 832/R-92-005-92, Storm Water Management for Construction Activities, Chapter 3.
- .2 Canadian Council of Ministers of the Environment (CCME), Environment Quality Guidelines.
- .3 Environment Canada, Section 36 (3) of the Fisheries Act – prohibits the planned or accidental discharge of deleterious substances to waters frequented by fish.
- .4 Environment Canada, migratory Birds Convention Act – prohibits the deposit of oil, oil wastes, or other substances harmful to migratory birds or in any area frequented by birds.
- .5 Any provincial Standards and Federal requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Prior to commencing construction activities or delivery of materials to site, provide Environmental Protection Plan for review by Departmental Representative.

.3 Ensure Environmental Protection Plan includes comprehensive overview of known or potential environmental; issues to be addressed during construction.

.4 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.5 Include Environmental Protection Plan:

.1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.

.2 Name sand qualification of person responsible for manifesting hazardous waste to be removed from site, and the name and location of the wastes destination (disposal facility).

.3 Names and qualifications of persons responsible for training program.

.4 Descriptions of environmental protection personnel training program.

.5 Spill Control Plan including procedures, instructions, and reports to be used in event of unforeseen spill regulated substance.

.6 Non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

.7 Air Pollution control plan detailing provisions t assure that dust, debris, materials, and trash, are contained on project site.

.8 Containment Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water or ground; and detailing provisions for compliance with federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

.9 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources , biological resources and wetlands.

1.4 FIRES

.1 Fires and burning of rubbish on site is not permitted.

1.5 HAZARDOUS MATERIAL HANDLING

.1 Store and handle hazardous materials in accordance with applicable federal and provincial laws, regulations, codes and guidelines. Store in location that will prevent spillage into the environment

.2 Label containers to WHMIS requirements and keep MSDS data sheets on site for all hazardous materials.

.3 Maintain inventory of hazardous materials and hazardous waste stored on site. List items by product name, quantity and date when storage began.

.4 Store and handle flammable and combustible materials in accordance with National Fire Code.

.5 Transport hazardous materials in accordance with federal Transportation of Dangerous Goods Regulations and applicable Provincial regulations.

1.6 DISPOSAL OF WASTES

.1 Do not bury rubbish and waste materials on site. Dispose in accordance with project waste management requirements specified in section 01 74 21.

.2 Do not dispose of hazardous waste or volatile materials, such as mineral spirits, paints, thinners, oil or fuel into waterways, storm or sanitary sewers or waste landfill sites.

.3 Dispose of hazardous waste in accordance with applicable federal and provincial laws, regulations, codes and guidelines.

1.7 SITE AND PLANT PROTECTION

.1 Protect trees and plants on site and adjacent properties where indicated.

.2 Wrap in burlap, trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2 m.

.3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.

.4 Minimize stripping of topsoil and vegetation.

.5 Restrict tree removal to areas indicated or designated by Departmental Representative.

1.8 WORK ADJACENT TO WATERWAYS

.1 Do not operate construction equipment in waterways.

.2 Do not use waterway beds for borrow material without Departmental Representative's approval.

.3 Do not dump excavated fill, waste material or debris in waterways.

.4 At borrow sites, design and construct temporary crossings to minimize erosion to waterways in strict conformance with provincial federal environmental regulations.

.5 Do not skid logs or construction materials across waterways.

.6 Avoid indicated spawning beds when constructing temporary crossings of waterways.

.7 Do not blast under water or 100 m of spawning beds.

.8 Do not refuel any type of equipment within 100 meters of a water body. Maintain equipment in good working condition with no fluid leaks, loose hoses or fittings.

1.9 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this Contract.

.2 Control emissions from equipment and plant to local authorities emission requirements.

.3 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads and around entire construction site.

.5 Have appropriate emergency spill response equipment and rapid clean-up kit on site located adjacent to hazardous materials storage area. Provide personal protective equipment required for clean-up.

.6 Report, spills of petroleum and other hazardous materials as well as accidents having potential of polluting the environment to Federal and Provincial Department of the Environment.
.1 Notify Departmental Representative and submit a written spill report to Departmental Representative within 24 hours of occurrence.

1.10 WILDLIFE PROTECTION

.1 Should nests of migratory birds in wetlands be encountered during work, immediately notify Departmental Representative for directives to be followed.
.1 Do not disturb nest site and neighbouring vegetation until nesting is completed.
.2 Minimize work immediately adjacent to such areas until nesting is completed.
.3 Protect these areas by following recommendations of Canadian Wildlife Service.

1.11 HISTORICAL ARCHAEOLOGICAL CONTROL

.1 Provide archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area discovered during construction.

.2 Plan: include methods to assure; protection of known or discovered resources and identify lines of communication between Contractor personnel and Departmental Representative.

1.12 NOTIFICATION

.1 Departmental Representative will notify Contractor in writing observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection Plan.

.2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.

  .1 Do not take action until after receipt of written approval by Departmental Representative.

.3 Departmental Representative may issue stop order of work until satisfactory corrective action has been taken.

.4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 CLEANING

.1 Ensure public waterways, storms and sanitary sewers remain free of waste and volatile materials disposal.

.2 Perform final decontamination of construction facilities, equipment and materials which may have come in contact with potentially contaminated materials prior to removal from site.

  .1 Perform decontamination as specified and to satisfaction of Departmental Representative and in accordance with regulatory requirements.

3.2 MITIGATION OF IMPACTS

.1 The proponent must ensure that a copy of these "Environmental Requirements" will be readily available on site for inspection and reference purposes during construction phase of the project and that all contractors and their agents will be made aware of and respect the following requirements where applicable to their direct involvement in the work.

.2 Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Refueling must be done at least 30 m from any water body and on an impermeable surface. Basic petroleum spill clean-up equipment should be on site. All spills or leaks should be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-565-1633).

.3 Fuel level must be inspected on a daily basis to ensure there is no leakage to the surrounding environment.

.4 All construction waste material will be disposed of in a provincially approved manner.

.5 All equipment must be maintained in proper running order to prevent leaking or spilling of potentially hazardous or toxic products. This includes hydraulic fluid, diesel, gasoline and other petroleum products.

.6 All waste materials will be disposed of according to Provincial Waste Management Regulations so as to mitigate potential effects generated by leachate entering soils.

.7

.8 Existing potentially hazardous materials are listed in Section 01 35 29 – Health and Safety Requirements.

.9 Engines must not be allowed to idle between work periods.

.10 Al machinery must be well muffled. If necessary, trucks may be required to avoid the use of “hammer” braking along specific sections of the route.

.11 Contractors must ensure that food scraps and garbage are not left at the work site.

END OF SECTION

1.1 RELATED SECTIONS

.1 Section 01 91 13.

1.2 INSPECTION

.1 Give timely notice requesting inspection of Work designated for special tests, inspections or approvals by Departmental Representative or by inspection authorities having jurisdiction.

.2 In accordance with the General Conditions, Departmental Representative may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents.

.3 If Contractor covers or permits to be covered Work designated for special tests, inspections or approvals before such is made, uncover Work until particular inspections or tests have been fully and satisfactorily completed and until such time as Departmental Representative gives permission to proceed.

.4 Pay costs to uncover and make good work disturbed by inspections and tests.

1.3 TESTING

.1 Tests on materials, equipment and building systems as specified in various sections of the Specifications is the responsibility of the Contractor except where stipulated otherwise.
   .1 Provide all necessary instruments, equipment and qualified personnel to perform tests.

.2 At completion of tests, turn over 2 sets of fully documented tests reports to the Departmental Representative. Submit in accordance with Section 01 33 00.
   .1 Obtain additional copies for inclusion of a complete set in each of the maintenance manuals specified in Section 01 78 00.

.3 Unspecified tests may also be made by Departmental Representative, at the discretion of the Departmental Representative. The costs of these tests will be paid for by the Departmental Representative.

.4 Where tests or inspections reveal work not in accordance with contract requirements, Contractor shall pay costs for additional tests and inspections incurred by Departmental Representative as required to verify acceptability of corrected work.

.5 Independent Inspection/Testing Agencies may be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work.

1.4 REJECTED WORK

.1 Remove and replace defective Work, whether result of poor workmanship, use of defective or damaged products and whether incorporated in Work or not, which has been identified by Departmental Representative as failing to conform to Contract Documents.

.2 Make good damages to new and existing construction and finishes resulting from removal or replacement of defective work.

1.5 ACCESS TO WORK

.1 Allow inspection /testing agencies access to Work.

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

1.6 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 space to store and cure test samples.

END OF SECTION

1.1 SITE ACCESS AND PARKING

.1 The Departmental Representative will designate Contractor's access to project site as well as parking facilities for equipment and workers.

.2 Parking facilities at site is limited. If insufficient , make arrangements elsewhere for Contractor’s vehicles including those subcontractors and workers.

1.2 BUILDING ACCESS

.1 Use only access doors, and circulation routes and elevators within building as designated by Departmental Representative to access interior work.

.2 Main site access across roof to Mechanical Penthouse.

1.3 CONTRACTOR'S SITE OFFICE

.1 Be responsible for and provide own site office, if required, including electricity, heat, lights and telephone. Locate site office as directed by Departmental Representative.

1.4 MATERIAL STORAGE

.1 Locate site storage trailors where directed by Departmental Representative. Place in location of least interference with existing Facility operations.

.2 Material storage space on site is limited does not exist. Coordinate delivery to minimize storage period on site before being needed for incorporation into work.

.3 Make arrangements elsewhere in the vicinity as deemed required and pay all costs for storage of materials not ready for incorporation into work.

1.5 PEDESTRIAN WALKWAYS AND HOARDING

.1 Ensure maximum safety and security to facility users during the course of work.

.2 Be responsible for and provide temporary 2.4 metre high plywood construction hoarding when work is adjacent to exterior sidewalks and circulation routes used by facility employees and public.

.3 Maintain access and eggress to building entrances and fire exits designated by Departmental Representative to remain in use. Provide enclosed walkways when work is adjacent to such doors as follows:
  - .1 Erect wooden pedestrian walkway complete with roof and side covers.
  - .2 Install walkways as soon as work is in the viscinity of entrance and exit doors and poses a potential danger to facility users.
  - .3 Construct to approximate size of 2.0 metre wide x 2.1 metre high x length as required to fully clear danger zone.
  - .4 Provide signage and lighting.

.5 Submit details of walkway size, location, layout and construction to Departmental Representative beforehand and obtain approval.

.4 Adequately frame and brace hoarding and walkways to resist wind, and other weather or site conditions.

.5 Erect such protective devices during Facility's non-operational off hour periods.

.6 Obtain Departmental Representative's concurrence prior to removal of hoarding and walkways.

1.6 INTERIOR HOARDING

.1 If required, erect hoarding inside building to isolate construction areas and protect occupants public for duration of work.

.2 Construct hoarding as follows:
.1 Height: to underside of floor or roof above.
.2 Framing type: as required.
.3 Covering: 12 mm thick.
.4 Sealed to abutting surfaces.
.5 Access Doors: quantity wood or steel pedestrian door dust tight lockable.
.6 Scribed to underside and profile of ceiling, floor/roof deck above.

1.7 INTERIOR DUST CONTROL AND DUST BARRIERS

.1 The AAFC Facility, including most Building-C Labs will remain in operation at all times during this project.

.2 Control creation and spread of dust and dirt to building interior to areas within premises still under use by occupants and in particular to the computer room. Special care must be taken to ensure no dust or dirt enter the computer facility.

.3 Develop and implement a dust control plan, addressing effective measures to carry out work with least amount of dust being created and propagated.
.1 Carefully evaluate the type of work to be undertaken and the physical layout of each work area on site.
.2 Provide specifically tailored strategy for each work area.
.3 Pre-determine location and placement of dust barriers to confine resulting dust to immediate work area zone.
.4 Inform Departmental Representative of the proposed dust control measures to be followed at each work area and for each major dust generating activities. Obtain Departmental Representative's approval before proceeding with work.

.4 Dust control plan to incorporate as a minimum the following dust protection and cleaning requirements:
.1 Erect dustproof partitions completely around work area zones to fully isolate construction from other parts of the building.
.2 Construct dust partitions as follows:

.1 Use 10 mm polyethylene installed and sealed tightly to abutting walls, ceilings and floor with continuous duct tape along all edges and seams. Support in position with 38 x 89 wood framing at 400 mm o.c. Locate seams only at framing members and overlap sheeting by minimum of 150 mm.

.2 Use 12 mm thick drywall plywood installed to steel stud framing spaced at 400 o.c. for areas located in public and corridors in use by occupants

.1 Erect from floor to underside of ceiling floor/roof deck above, sheeting applied to occupied side of partition. Install polyethylene for remainder of partition height to underside of floor/roof deck above.

.2 Scribe, cut and fit sheething tight to shape of structural steel, deck profile and to other obstructions in ceiling space and abutting walls.

.3 Use compressable neoprene gaskets around perimeter of partition and at all protrusions to achieve airtight construction.

.4 Where partition is exposed to public view, tape and finish drywall joints and paint surface to color approved by the Departmental Representative.

.3 Provide a "dust tight" and lockable access door(s) within dust partition or between rooms for worker entry into work area. This is of particular importance for situations where excessive dust will be generated.

.4 Provide additional dust barriers, placed tightly to underside of the floor/roof deck above, in locations where existing walls are used as part of the dust barrier system but simply terminate at the finished ceiling level resulting in an open space above, or other similar condition, permitting dust to migrate beyond the construction areas.

.5 Make all dust barriers airtight, effectively blocking and stopping all dust migration.

.6 Inspect dust barriers at various intervals during each work shift. Immediately fix tears, unsealed edges and maintain barriers effectively sealed for the entire work duration.

.7 Shut down existing ventilation system feeding construction space, or disconnect and seal-off supply and return air ducts to stop dust from contaminating other areas.

.8 Immediately clean areas in use by occupants and public contaminated by work.

.1 Vaccum carpets, wash floors and walls. Remove accumulated dust from all surfaces. Clean and remove smears, scuffs and marks.

.5 Meager attempts at controlling dust will not be tolerated. Failure to provide effective dust control during work and to perform satisfactory cleaning thereafter will result in Departmental Representative to proceed and obtain a separate cleaning service agency to perform cleaning to tenant's satisfaction with cost for such services being charged against this Contract in the form of financial holdbacks.

.6 Obtain Departmental Representative's approval before erecting any dust partitions simply to underside of finish ceiling.

.7 Construction of dust barriers, enclosures and placement of temporary protective devices to be performed during Facility non-operational off-hour periods.

1.8 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

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

1.9 ENCLOSURE OF STRUCTURE

.1 Provide temporary weather tight enclosures and protection for exterior openings until permanently enclosed.

.2 Provide weather tight and heated enclosures to conduct exterior work during winter and other inclement weather conditions. Erect to allow accessibility for installation of materials and working inside of enclosure.

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

1.10 POWER

.1 Power supply is available and will be provided for construction usage at no cost.
  - .1 Make arrangements for the use of such services through the Departmental Representative.
  - .2 Departmental Representative will designate and approve each location of existing power source to which connections can be made to obtain temporary power service.
  - .3 Connect to existing power supply in accordance with CSA C22.1-12, Canadian Electrical Code.

.2 Provide and pay all costs to supply and install temporary cabling, panelboards, switching devices and other equipment as required to connect into power source, provide adequate ground fault protection and extend power supply from existing source to work areas. Perform work and make all connections in accordance with the CSA C22.1-12 Canadian Electrical Code, in compliance with the federal and provincial Occupational Health and Safety Regulations as specified in section 01 35 29 and to lockout requirements specified in section 01 35 25.

.3 Provide and maintain temporary lighting to conduct work. Ensure illumination level is not less than 162 lx in all locations.

.4 Electrical power and lighting systems installed under this Contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage. Replace lamps which have been used over period of 3 months.

1.11 WATER SUPPLY

.1 Water supply is available in existing building on site and will be provided for construction usage at no cost. Make arrangements for the use and transportation of such services to work area through the Departmental Representative.

.2 Permanent water supply system installed under this Contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage.

1.12 SCAFFOLDING

.1 Design, construct and maintain scaffolding in rigid, secure and safe manner in accordance with the following codes and standards:
   - .1 CAN/CSA-S269.2-M87 (R2003), Access Scaffolding for Construction Purposes.
   - .2 National Building Code of Canada (most recent edition).
   - .3 The Canada Labour Code Part II.
   - .4 The Nova Scotia Workplace Health and Safety Regulations, NS Reg 52/2013.

.2 Where codes and standards conflict, the most stringent shall apply.

.3 Erect scaffolding independent of walls. Remove when no longer required.

1.13 HEATING AND VENTILATING

.1 Supply, install and pay for costs of temporary heat and ventilation used during construction, including costs of installation, fuel, operation, maintenance and removal of equipment. Use of direct-fired heaters discharging waste products into work areas will not be permitted.

.2 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.

.3 Maintain minimum temperature of 10 degrees C, or higher where specified, as soon as finishing work is commenced and maintain until acceptance of structure by Departmental Representative.
   - .1 Maintain ambient temperature and humidity levels as required for comfort of office personnel.

.4 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.

.5 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.

.6 Submit bid assuming existing or new equipment and systems will not be used for temporary heating and ventilating.

.7 Upon acceptance of bid, Departmental Representative may permit use of permanent system providing agreement can be reached on:
.1 Conditions of use, special equipment, protection and maintenance.
.2 Saving on Contract price.
.3 Provisions relating to warranties on equipment.

1.14 CONSTRUCTION SIGN AND NOTICES

.1 Contractor or subcontractor advertisement signboards are not permitted on site.

.2 Safety and Instruction Signs and Notices:
.1 Signs and notices for safety and instruction shall be in both official languages or commonly understood graphic symbols conforming to CAN/CSA-Z321-96(R2006).

.3 Maintenance and Disposal of Site Signs:
.1 Maintain approved signs and notices in good condition for duration of project and dispose of off site on completion of project or earlier if directed by Departmental Representative.

1.15 REMOVAL OF TEMPORARY FACILITIES

.1 Remove temporary facilities from site when directed by Departmental Representative.

END OF SECTION

1.1 GENERAL

.1 Use new material and equipment unless otherwise specified.

.2 Within 7 days of written request by Departmental Representative, submit following information for any materials and products proposed for supply:
- .1 Name and address of manufacturer.
- .2 Trade name, model and catalogue number.
- .3 Performance, descriptive and test data.
- .4 Compliance to specified standards.
- .5 Manufacturer's installation or application instructions.
- .6 Evidence of arrangements to procure.
- .7 Evidence of manufacturer delivery problems or unforseen delays.

.3 Provide material and equipment of specified design and quality, performing to published ratings and for which replacement parts are readily available.

.4 Use products of one manufacturer for equipment or material of same type or classification unless otherwise specified.

.5 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.

1.2 PRODUCT QUALITY

.1 Contractor shall be solely responsible for submitting relevant technical data and independent test reports to confirm whether a product or system proposed for use meets contract requirements and specified standards.

.2 Final decision as to whether a product or system meets contract requirements rest solely with the Departmental Representative in accordance with the General Conditions of the Contract.

1.3 ACCEPTABLE MATERIALS AND ALTERNATIVES

.1 Acceptable Materials: When materials specified include trade names or trade marks or manufacturer's or supplier's name as part of the material description, select and only use one of the names listed for incorporation into the Work.

.2 Alternative Materials: Submission of alternative materials to trade names or manufacturer's names specified must be done during the bidding period following procedures indicated in the Instructions to Bidders.

.3 Substitutions: After contract award, substitution of a specified material will be dealt with as a change to the Work in accordance with the General Conditions of the Contract.

1.4 MANUFACTURERS INSTRUCTIONS

.1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods to be used. Do not rely on labels or enclosure provided with products. Obtain written instructions directly from manufacturers.

.2 Notify Departmental Representative in writing of any conflict between these specifications and manufacturer’s instructions, so that Departmental Representative will designate which document is to be followed.

1.5 AVAILABILITY

.1 Immediately notify Departmental Representative in writing of unforeseen or unanticipated material delivery problems by manufacturer. Provide support documentation as per clause 1.1.2 above.

1.6 WORKMANSHIP

.1 Ensure quality of work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed.

.2 Remove unsuitable or incompetent workers from site as stipulated in the General Conditions of the Contract.

.3 Ensure cooperation of workers in laying out work. Maintain efficient and continuous supervision on site at all times.

.4 Coordinate work between trades and subcontractors. See section 01 14 10 in this regard.

.5 Coordinate placement of openings, sleeves and accessories.

1.7 FASTENINGS - GENERAL

.1 Provide metal fastenings and accessories in same texture, colour and finish as base metal in which they occur. Prevent electrolytic action between dissimilar metals. Use non-corrosive fasteners, anchors and spacers for securing exterior work and in humid areas.

.2 Space anchors within limits of load bearing or shear capacity and ensure that they provide positive permanent anchorage. Wood or organic material plugs not acceptable.

.3 Keep exposed fastenings to minimum, space evenly and lay out neatly.

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

.5 Do not use explosive actuated fastening devices unless approved by Departmental Representative. See section on Health and Safety Requirements in this regard.

1.8 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.

.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 and, use resilient washers with stainless steel.

1.9 STORAGE, HANDLING AND PROTECTION

.1 Deliver, handle and store materials in manner to prevent deterioration and soiling and in accordance with manufacturer's instructions when applicable.

.2 Store packaged or bundled materials in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work. Provide additional cover where manufacturer's packaging is insufficient to provide adequate protection.

.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 and 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 Immediately remove damaged or rejected materials from site.

.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.

1.10 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 of there os interference. Install as directed by Departmental Representative.

1.11 REMEDIAL WORK

.1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.

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

1.12 EXISTING UTLITIES

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

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

END OF SECTION

1.1 GENERAL

.1 Conduct cleaning and disposal operations to comply with local ordinances and antipollution laws.

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

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

1.2 MATERIALS

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

1.3 CLEANING DURING CONSTRUCTION

.1 Maintain work areas in a tidy condition, free from accumulations of waste material and debris. Clean areas on a daily basis.

.2 Keep building entrances, corridors, stairwells and tenant occupied areas of building in a clean dust free condition at all times. Conduct thorough cleaning of these areas at end of each workshift when used by workers or affected by the Work.

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

.4 Use separate collection bins, clearly marked as to purpose, for source separation and recycling of waste and debris in accordance with waste management requirements specified.

.5 Remove waste materials, and debris from site on a daily basis.

.6 Provide dust barriers, dividers, seals on doors and employ other dust control measures as required to ensure that dust and dirt, generated by work, are not transmitted to other existing areas of building. Should dust migrate into tenant occupied and public areas of building, employ such means as may be necessary to immediately clean all contaminated surfaces to the satisfaction of the Departmental Representative.

    .1 See Section 01 50 00 for requirements on dust control and for erection of dust partitions.

.7 Immediately clean all dust, dirt, smears, scuffs and soiled surfaces in lobbies, corridors, stairwells and within tenant occupied areas resulting from the Work.

    .1 Perform cleaning, dusting and washing operations, carpet vacuuming (including shampooing if deemed required by Departmental Representative) and floor washing as necessary to thoroughly clean all soiled surfaces.

.8 Remove snow and ice from access doors used by workforce. Be responsible for snow removal from areas of work site and as required to access work site area.

1.4 FINAL CLEANING

.1 In preparation for acceptance of the completed work perform final cleaning.

.2 Replace items with broken pieces, scratches or disfigured.

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

.4 Vacuum clean and dust building interiors, behind grilles, louvers and screens.

.5 Inspect finishes, fitments and equipment. Ensure specified workmanship and operation.

.6 Broom clean and wash exterior paved surfaces and walks; rake clean other surfaces of grounds.

.7 Remove debris and surplus materials from crawl areas, roof areas and other accessible concealed spaces.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Deconstruction: systematic dismantling of structure in a manner that achieves safe removal/disposal of hazardous materials.

.2 Demolition: rapid destruction of structure with or without prior removals of hazardous materials.

.3 Hazardous materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, including, but not limited to,: asbestos-containing materials, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other of handled improperly.

.4 Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment or disposal.

.5 Inert fill: inert waste – exclusively asphalt and concrete.

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

1.2 WASTE MANAGEMENT

.1 Incorporate environmental and sustainable practices in managing waste resulting from work.

.2 Divert as much waste as possible from landfill.

.3 Coordinate work of subtrades and subcontractors to ensure all possible waste reduction and recycling opportunities are taken. Follow waste management requirements specified in trade sections of the Specifications.

.4 Reduce waste during installation of new materials. Undertake practices which will optimize full use of materials and minimize waste.

.5 Develop innovative procedures to reduce quantity of waste generated by construction such as by delivering materials to site with minimal packaging etc.

.6 Provide on-site facilities to collect, handle and store anticipated quantities of reusable, salvageable and recyclable materials.

.7 During demolition and removal work separate materials and equipment at source, carefully dismantling, labelling and stockpiling alike items for the following purposes:
  .1 Reinstallation into the work where indicated.
  .2 Salvaging reusable items not needed in project which Contractor may sell to other parties.
  .3 Sending as many items as possible to locally available recycling facility.

.4 Segregating remaining waste and debris into various individual waste categories for disposal in a "non-mixed state" as recommended by waste processing/landfill sites.

.8 Isolate product packaging and delivery containers from general waste stream. Send to recycling facility or return to supplier/manufacturer.

.9 Send leftover material resulting from installation work for recycling whenever possible.

.10 Establish methods whereby hazardous and toxic materials, and their containers used on site are properly handled, stored and disposed in accordance with applicable federal, provincial and municipal laws and regulations.

1.3 DISPOSAL REQUIREMENTS

.1 Burying or burning of rubbish and waste materials is prohibited.

.2 Disposal of volatile materials, mineral spirits, oil, paint, and other hazardous materials into waterways, storm, or sanitary sewers is prohibited.

.3 Dispose of waste only at approved waste processing facility or landfill sites approved by authority having jurisdiction.

.4 Contact the authority having jurisdiction prior to commencement of work, to determine what, if any, demolition and construction waste materials have been banned from disposal in landfills and at transfer stations. Take appropriate action to isolate such banned materials at site of work and dispose in strict accordance with provincial and municipal regulations.

.5 Transport and dispose of waste intended for waste processing plant or landfill facility in separated condition and to Operator's rules and recommendations in support of their effort to recycle, reduce and divert certain waste stream from general landfill.

.6 Collect, bundle and transport salvaged materials to be recycled in separated categories and condition as directed by recycling facility. Ship materials only to approved recycling facilities.

.7 Sale of salvaged items by Contractor to other parties not permitted on site.

1.4 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International):

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

.2 Federal Legislation:

.1 Canadian Environmental Assessment Act (CEAAQ), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.3 National Building Code 2010, Part 8, - Safety measures at Construction and Demolition Sites.

1.5 DOCUMENTS

.1 Maintain at job, one copy of the following:

.1 Site Specific Health and Safety Plan.
.2 Environment Protection Plan.
.3 Materials removal log.

1.6 SUBMITTALS

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

1.7 STORAGE HANDLING AND PROTECTION

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

.2 Prevent contamination of materials to be recycled and handle material in accordance with requirements for acceptance by designated facilities.

1.8 DISPOSAL OF WASTES

.1 Do not bury rubbish or waste materials.

.2 Do not dispose of waste, volatile materials, mineral spirits, oil into waterways, storms, or sanitary sewers.

.3 Remove materials from deconstruction as deconstruction/disassembly Work progresses.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Transport hazardous materials and wastes, in accordance with Transportation of Dagerous Goods Regulations, and applicable provincial regulations.

.1 Comply with applicable federal, provincial and municipal laws and regulations for generators of hazardous waste.
.2 Use licensed carrier authorized by provincial authorities to accept subject material.
.3 Before shipping material obtain written notice from intended material and it is licensed to accept this material. Provide photocopy of notice to the Departmental Representative.
.4 Label container(s) with legible, visible safety marks as prescribed by federal and provincial regulations.
.5 Only trained personnel handle, offer for transport, or transport dangerous goods.

.6 Provide photocopy of shipping documents and waste manifests to the Departmental Representative.

.7 Track receipt of completed manifest from consignee after shipping dangerous goods. Provide photocopy of completed manifest to Departmental Representative.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 APPLICATION

.1 Complete removal of all hazardous materials prior to undertaking deconstruction/demolition activities.

3.2 REMOVAL OF HAZARDOUS MATERIALS

.1 Remove existing perchloric fume hoods and associated fans and ductwork after specialized cleaning procedures have been completed and tested.

.2 Remove existing redundant fume hoods, fume hood fans and ductwork after proper cleaning and decontamination procedures.

3.3 DEMOLITION AND DECONSTRUCTION

.1 On site sale of salvaged, reusable, recyclable, materials is not permitted.

.2 Ensure workers and subcontractors are trained to carry out work in accordance with appropriate deconstruction techniques.

3.4 Cleaning

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

.2 Clean-up work area ass work progresses.

END OF SECTION

1.1 SECTION INCLUDES

.1 Administrative procedures preceeding inspection and acceptance of Work by Departmental Representative.

1.2 RELATED SECTIONS

.1 Section 01 78 00: Closeout Submittals.

1.3 INSPECTION AND DECLARATION

.1 Contractor's Inspection: Coordinate and perform, in concert with subcontractors, an inspection and check of all Work. Identify and correct deficiencies, defects, repairs and perform outstanding items as required to complete work in conformance with Contract Documents.

  .1 Notify Departmental Representative in writing when deficiencies from Contractor's inspection have been rectified and that Work is deemed to be complete and ready for Departmental Representative's inspection of the completed work.

.2 Departmental Representative's Inspection: Accompany Departmental Representative during all substantial and final inspections of the Work.

  .1 Address defects, faults and outstanding items of work identified by such inspections.
  .2 Advise Departmental Representative when all deficiencies identified have been rectified.

.3 Note that Departmental Representative will not issue a Certificate of Substantial Performance of the work until such time that Contractor performs following work and turns over the specified documents:

  .1 Project record as-built documents;
  .2 Final Operations and Maintenance manuals;
  .3 Maintenance materials, parts and tools;
  .4 Compliance certificates from applicable authorities;
  .5 Reports resulting from designated tests;
  .6 Demonstration and training complete with user manuals;
  .7 Manufacturer's Guarantee certificates.
  .8 Testing, adjusting and balancing of equipment and systems complete with submission of test reports.
  .9 Commissioning of equipment and systems specified.

.4 Correct all descrepancies before Departmental Representative will issue the Certificate of Completion.

END OF SECTION

1.1 SECTION INCLUDES

.1 Project Record Documents.

.2 Operations and Maintenance data.

1.2 RELATED SECTIONS

.1 Section 01 79 00: Demonstration and Training.

1.3 PROJECT RECORD DOCUMENTS

.1 Departmental Representative will provide 2 white print sets of contract drawings and 2 copies of Specifications Manual specifically for "As-Built" purposes.

.2 Maintain at site one set of the contract drawings and specifications to record actual As-Built site conditions.

.3 Maintain up-to-date, real time as-built drawings and specifications in good condition and make available for inspection by the Departmental Representative upon request.

.4 As-Built Drawings:
- .1 Record changes in red ink on the prints. Mark only on one set of prints and at completion of work, neatly transfer notations to second set (also by use of red ink).
- .2 Submit both sets to Departmental Representative prior to application for Certificate of Substantial Performance.
- .3 Stamp all drawings with "As-Built". Label and place Contractor's signature and date.
- .4 Show all modifications, substitutions and deviations from what is shown on the contract drawings.
- .5 Record following information:
  - .1 Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure;
  - .2 Field changes of dimension and detail;
  - .3 Location of all capped or terminated services and utilities.
  - .4 Chases for mechanical, electrical and other services;
  - .5 Ceiling and floor elevations;
  - .6 Reflected ceiling plan condition showing finished layout of all ceiling-mounted services and devices;
  - .7 Plumbing, heating, air conditioning and ventilation, sprinkler and electrical service installation locations; all to be dimensioned and referenced to building columns or load bearing walls;
  - .8 All structural steel installations to be fully dimensioned;
  - .9 All design elevations, sections, floor plans and details dimensioned and marked-up to consistently report finished installation conditions;
  - .10 Any details produced in the course of the contract by the Departmental Representative to supplement or to change existing design drawings;

.11 All change orders issued over the course of the contract must be documented on the finished As-Built documents, accurately and consistently depicting the changed condition as it applies to all affected drawing details.

.6 Maintain As-Built documents current as the contract progresses. Departmental Representative will conduct reviews and inspections of the documents on a regular basis. Failure to maintain as-builts current and complete to satisfaction of the Departmental Representative shall be subject to financial penalties in the form of progress payment reductions and holdback assessments.

.7 Submit on paper and in electronic format as pdf files. Forward pdf and in the native program format, NMSEdit Professional spp, MS Word, MS Excel, MS Project and Autocad dwg and photograph jpg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

1.4 REVIEWED SHOP DRAWINGS

.1 Provide a complete set of all shop drawings reviewed for project to incorporate into each copy of the Operations and Maintenance Manuals.

.2 Submit full sets at same time and as part of the contents of the Operation and Maintenance Manuals specified.

1.5 UPDATING OF DIGITAL DRAWINGS

.1 Obtain and pay for the services of a qualified drafting firm to update the digital files which were used to produce the contract drawings.

- .1 Update the digital drawing files with the same As-Built information as specified for the paper As-Built drawings.
- .2 Supply of digital documents does not replace the requirement to provide marked-up white prints specified above.

.2 The Departmental Representative will provide a copy of the digital drawing files.

.3 Incorporate the as-built changes to the digital drawings by following the standards specified in the latest version of the PWGSC National CADD Standard. A copy of this manual will be provided by the Departmental Representative.

.4 Make revisions to electronic files found to be in non-conformance with the PWGSC National CADD Standard as directed by Departmental Representative

.5 In regards to updating the digital files to reflect changes resulting from Change Orders, the change in cost of completing the As-Built documentation of changes is to be included in the amount for each Change Order issued. The amount included will constitute only the increase or decrease in CADD related costs resulting directly from the change. In determining the cost difference, full consideration will be given to the fact that other clauses of this section require As-Built CADD updates to the drawings irrespective of any Change Orders.

.6 Deliver the digital As-Built information in same format and sequence as the contract drawings and specifications.
.1 Submit on PWGSC encrypted USB.
.2 Provide 1 full set of paper plots.
.3 Submit the digital As-Builts at the same time as the marked-up paper white prints.

1.6 OPERATIONS & MAINTENANCE MANUAL

.1 O&M Manual - Definition: an organized compilation of operating and maintenance data including detailed technical information, documents and records describing operation and maintenance of individual products or systems as specified in individual sections of the specifications.

.2 Manual Language: final manuals to be in both English and French languages.
.1 Upon review and acceptance by Departmental Representative, submit 2 final copies. Interim copies are not to be considered as part of the final copies unless they have been fully revised and are identical to the final approved version.

.3 Submission Date: submit complete operation and maintenance manual to Departmental Representative 3 weeks prior to application for Certificate of Substantial Performance of the work.

.4 Binding:
.1 Assemble, coordinate, bind and index required data into Operation and Maintenance Manual.
.2 Use vinyl, hard covered, 3 "D" ring binders, loose leaf, sized for 215 x 280 mm paper, with spine pocket.
.3 Where multiple binders are needed, correlate data into related consistent groupings.
.4 Identify contents of each binder on spine.
.5 Organize and divide data following same numerical system as the section numbers of the Specification Manual.
.6 Dividers: separate each section by use of cardboard dividers and labels. Provide tabbed fly leaf for each individual product and system and give description of product or component.
.7 Type lists and notes. Do not hand write.
.8 Drawings, diagrams and manufacturers' literature must be legible. Provide with reinforced, punched binder tab. Bind in with text; fold larger drawings to size of text pages.

.5 Manual Contents:
  .1 Cover sheet containing:
    .1 Date submitted.
    .2 Project title, location and project number.
    .3 Names and addresses of Contractor, and all Sub-Contractors.
  .2 Table of Contents: provide full table of contents in each binder(s), clearly indicate which contents are in each binder.
  .3 List of maintenance materials.
  .4 List of spare parts.
  .5 List of special tools.
  .6 Original or certified copy of warranties and product guarantees.
  .7 Copy of approval documents and certificates issued by Inspection Authorities.
  .8 Copy of reports and test results performed by Contractor as specified.
  .9 Product Information (PI Data) on materials, equipment and systems as specified in various sections of the specifications. Data to include:
    .1 List of equipment including manufacturer's name, supplier, local source of supplies and service depot(s). Provide full addresses and telephone numbers.
    .2 Nameplate information including equipment number, make, size, capacity, model number and serial number.
    .3 Parts list.
    .4 Installation details.
    .5 Operating instructions.
    .6 Maintenance instructions for equipment.
    .7 Maintenance instructions for finishes.

.6 Shop drawings:
  .1 Include complete set of reviewed shop drawings into each copy of the operations and maintenance manual.
  .2 Fold and bind material professionally in a manner that corresponds with the specification section numbering system.
  .3 When large quantity of data is submitted, place into separate binders of same size as O&M binders.

.7 Equipment and Systems Data: the following list indicates the type of data and extent of information required to be included for each item of equipment and for each system:
  .1 Description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. 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. Include regulation, control, stopping, shut-down, and emergency instructions. 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 Servicing and lubrication schedule, and list of lubricants required.
.7 Manufacturer's printed operation and maintenance instructions.
.8 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 coordination 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.
.15 Additional requirements as specified in individual specification sections.

.8 Materials and Finishes Maintenance Data:
.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
.3 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.
.4 Additional Requirements: as specified in individual specifications sections.

1.7 SPARE PARTS, TOOLS AND MAINTENANCE MATERIALS

.1 Provide spare parts, special tools and extra materials for maintenance purposes in quantities specified in individual specification sections.

.2 Tag all items with associated function or equipment.

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

.4 Deliver to site in well packaged condition. Store in location as directed by Departmental Representative.

.5 Clearly mark as to contents indicating:
.1 Part number.
.2 Identification of equipment or system for which parts are applicable.
.3 Installation instructions or intended use as applicable.
.4 Name, address and telephone number of nearest supplier.

.6 Prepare and submit complete inventory list of items supplied. Include list within Maintenance Manual.

END OF SECTION

1.1 RELATED SECTIONS

.1 Operations and Maintenance Manual: Section 01 78 00.

1.2 DESCRIPTION

.1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel prior to date of final inspection.

.2 Departmental Representative will provide a list of Owner's personnel to receive instructions,

.3 Cooperate with Departmental Representative in coordinating time and attendance of Owner's personnel with manufacturer's training Representative(s).

1.3 QUALITY CONTROL

.1 Ensure that only personnel from own forces, Subcontractors or Suppliers competent and fully knowledgeable in the particular material component, equipment or system installation are used to provide training and demonstrations.

.2 When specified in individual Sections, obtain the manufacturers authorized Representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.

.3 Upon request, provide evidence to Departmental Representative of individual Trainor's knowledge and qualifications.

1.4 SUBMITTALS

.1 Submit schedule of time, date and complete list of equipment and systems for which demonstration and training sessions will be provided. Submit schedule a minimum of 2 weeks prior to designated dates, for Departmental Representative's approval.

.2 Submit report within 1 week after completion of demonstration, that demonstration and instructions have been satisfactorily completed. Provide time and date of when each demonstration was actually given, with list of persons present.

1.5 CONDITIONS FOR DEMONSTRATIONS

.1 Prior to carrying out demonstration and training, ensure that equipment has been inspected and tested, is fully operational, has been performance verified and TAB has been carried out.

.2 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.6 PREPARATION

.1 Verify that conditions for demonstration and instructions comply with requirements.

.2 Verify that designated personnel are present.

1.7 DEMONSTRATION AND INSTRUCTIONS

.1 Include the following items within the demonstration and training:
- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each of equipment.
- .2 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- .3 Review contents of manual in detail to explain all aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.
- .5 Provide other specific training and instructions as specified in trade sections.

1.8 TIME ALLOCATED FOR INSTRUCTIONS

.1 Observe the allocated time period specified in trade sections. Provide additional time when required to ensure all personnel fully understand all aspects of the information and instructions being provided. Allow for questions by participants.

END OF SECTION

1.1 SECTION INCLUDES

.1 This section deals with commissioning activities to occur during the construction stage and the early period of facility occupancy stage.

.2 Section includes:
.1 Commissioning activities to be performed by the Contractor who is assigned membership on a Commissioning Team as part of the contract requirements.
.2 Commissioning activities to be performed by other members of the Commissioning Team.

.3 In general, Contractor's commissioning activities consists of performing specified tasks and functions to assist the Commissioning Agent, along with other members of the commissioning team who will commission various components and systems of the Facility.

1.2 RELATED SECTIONS

.1 Operations and Maintenance Manuals: Section 01 78 00.

.2 Demonstration and Training: Section 01 79 00.

1.3 BACKGROUND INFORMATION

.1 Historically in the past, the term commissioning has been used in reference to the process used to conduct testing, adjusting and balancing of the heating, ventilation and air conditioning (HVAC) systems of a building.

.2 Commissioning (or the commissioning process), as understood by PWGSC, is a planned program of activities conducted in concert with other activities performed during each stage of project delivery.
.1 The commissioning process identifies issues during the Planning and Design stages which are addressed during the Construction and Occupancy Stages of a Facility to ensure that the built facility is constructed and proven to operate satisfactorily under all weather, environmental and occupancy conditions to meet operational and user requirements.
.2 Commissioning activities during the Construction stage incorporates a third party verification process and a transfer of critical operational knowledge to Facility personnel.

1.4 COMMISSIONING OBJECTIVES

.1 A Commissioning Plan has been prepared by the Design Consultant, on behalf of PWGSC, which identifies, among other issues, specific commissioning activities to be carried out by the commissioning team during the Construction and Occupancy Stages of the project.

.2 The commissioning activities have the following objectives:
  .1 Collect data on equipment and systems being supplied and document their installation;
  .2 Conduct checks and tests on fully installed building components, equipment, systems and intregrated systems to:
    .1 Verify whether they operate in accordance with requirements of Contract Documents;
    .2 Verify performance against design criteria and user requirements and measure peak capacities;
  .3 Prepare a Building Management Manual (BMM) which contains operations and maintenance data, as-built record documents, commissioning reports, training data and other critical information for future use by Facility operational staff;
  .4 Ensure transfer of knowledge on the operations, maintenance and management of the Facility to Tenant and Operational personnel by means of appropriate training.

.3 Work to achieve the above objectives requires a collaborative effort from all members of the commissioning team.
  .1 Contractor's commissioning activities and responsibilities are described in Clause 1.8 below.

.4 Commissioning activities performed by the Commissioning Agent and the Design Consultant does not replace checks, tests, adjustments, balancing and other performance verification procedures to be carried out by the Contractor as an integral part of performing the Work of this contract as specified in other sections of the Specifications.

1.5 SYSTEMS TO BE COMMISSIONED

.1 The following systems and controls, complete with associated equipment and components, will be commissioned by the Commissioning Agent and requires related commissioning activities to be performed by Contractor as specified herein and in section(s):
  .1 New Laboratory ventilation and heating systems.
  .2 New fume hood exhaust systems served by High-Fume FH Exhaust Fans, FF-1 and FF-2.
  .3 New General Exhaust System served by general exhaust Fan GE-1.
  .4 New fume hoods.
  .5 New SF-5A, SF-5B, RF-SA, and RF-5A and RF-5B, Variable Frequency Drives.
  .6 New digital laboratory control system and VAV fume hood controls.
  .7 New SF-5A and SF-5B Air Handling Unit digital control system.

1.6 DEFINITIONS

.1 For the purpose of this contract, the various terms listed below, as they relate directly or indirectly to the commissioning process, shall be deemed to have the following meaning.

.2 Commissioning Process: a planned program of tasks, activities and procedures carried out systematically during the Construction and Occupancy Stages in accordance with the commissioning objectives, specified in clause 1.4.2 above, to:

  .1 Verify whether the fully installed equipment, systems and intergrated systems operate in accordance with contract documents and design criteria and;

  .2 Ensure that appropriate documentation is compiled to effectively train O& M staff and prepare a comprehensive Building Management Manual (BMM).

.3 Commission (ie: to commission a building component or system): tests and checks conducted by Commissioning Agent on all systems and intergrated systems of Facility; carried out only after they are fully installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.

  .1 Contractor provides assistance during this process by operating equipment and systems, by troubleshooting and making adjustments as may be required.

  .2 Systems are run under their full operation and under various modes to determine if they function correctly, consistently, at peak efficiency and interactively with each other as intended in accordance with Contract Documents and design criteria.

  .3 During these checks, adjustments may be made enhancing performance to meet environmental or user requirements.

.4 Commissioning Agent: a specifically appointed person, representing the Departmental Representative, responsible for the development of a Commissioning Plan and managing it's implementation by overseeing and coordinating various activities and responsibilities to be performed by members of the Commissioning Team.

  .1 In this project, the Commissioning Agent is part of the engineering consultant firm engaged by PWGSC to prepare the final design and contract documents for this Work.

  .2 Commissioning Agent plays a lead role in support to the Departmental Representative to ensure that the commissioning objectives are achieved.

.5 Commissioning Manager: a PWGSC departmental employee providing advice and guidance on commissioning requirements to the Commissioning Agent in support to the Departmental Representative.

.6 Commissioning Plan: the document which describes the organization, scheduling, allocation of resources, required documentation, target dates, and team roles and responsibilities for verification that the built works meet Contract Document and design criteria requirements.

.7 Contractor: means the General Contractor, however it also refers to any personnel from subcontractors, including the controls and TAB specialists, suppliers and manufacturer's technical persons which Contractor employs to carry out his/her designated commissioning duties and activities.

.8 Design Consultant: persons from the civil, architectural, mechanical and electrical design disciplines of the engineering firm(s) which have been engaged by the Departmental Representative to prepare the final design and produce the contract documents. Design Consultant also has specifically identified commissioning activities for this project.

.9 Design Criteria: All those factors included in the design of a Facility prescribed by the tenant needs or as determined by Designer as necessary in order to meet all Facility functional and user operational requirements

.10 Installation/Start-up Checks: (sometimes referred to as pre-functional checks) A written compilation of checks and inspections to be performed by Contractor during the pre-start-up and start-up of a particular equipment or system component.

- .1 Checklist sheets are produced which include the following data:
  - .1 Product manufacturer's installation instructions and recommended checks and;
  - .2 Special procedures as specified in relevant sections of Specifications;
  - .3 Other items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Standard Installation/Start-Up Checklist sheets prepared by equipment manufacturer are acceptable for use. However, supplement with additional data representative of specific project conditions as deemed required by Commissioning Agent.
- .3 Use Checklist sheets for all equipment installation. Document in writing on checklist the various checks made, deficiencies noted and corrective action taken.
- .4 Installer to sign Checklist sheets upon completion, certifying that stated checks and inspections have been performed.
- .5 Use of Installation/Start-Up Checklists shall not be considered part of the commissioning process but shall be stringently used for all equipment pre-start and start-up procedures.
- .6 Return completed Installation/Start-Up Checklist sheets after use to Commissioning Agent for retention. Checklists are required by Commissioning Agent when Facility is commissioned and will be included in the BMM manual at completion of project.

.11 Performance Verification: (sometimes referred to Functional Testing) checks, running dynamic tests and adjustments carried out by Contractor on equipment and systems, upon their installation, to ensure they operate correctly, efficiently and function independently and interactively with other systems as intended in accordance with contract documents and manufacturer's recommendations.

- .1 Performance Verification shall not be considered part of the commissioning process. It is however considered an essential and integral part of Contractor's responsibilities in the equipment installation process which must be stringently conducted, successfully completed and approved by Departmental Representative before a piece of equipment or system is considered fully installed and functional.
- .2 Facility components and systems will not be commissioned by Commissioning Agent until performance verification has been completed and approved.

.12 Performance Verification Report Sheets (PV sheets): forms developed by Commissioning Agent for Contractor's use to record measured data and readings taken during functional testing and Performance Verification procedures.

.13 Product Information (PI Data): a compilation of data gathered on a particular piece of equipment, typically produced by manufacturer, which includes nameplate information, installation/startup instructions, parts list, operating instructions, maintenance guidelines and other pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of such equipment. This documentation is included in the Building Management Manual (BMM) at completion of work.

1.7 COMMISSIONING TEAM

.1 A commissioning team will be assembled to carryout various functions needed to effectively commission the Facility. Contractor shall be part of this team with duties and responsibilities as specified in this section and in other sections of the Specifications.

.2 Effective commissioning requires coordination between members of the commissioning team. Cooperate with other team members in fulfilling assigned duties and as follows:
- .1 Communicate commissioning objectives, to subcontractors, suppliers and manufacturers.
- .2 Coordinate activities between subcontractors and trades as needed to carryout Contractor's assigned commissioning activities.
- .3 Ensure attendance of subcontractors and required specialist at commissioning meetings and during the commissioning process.

.3 Construction Commissioning Supervisor:
- .1 Assign a person, under Contractor's employ, to be the Construction Commissioning Supervisor.
- .2 Person to be knowledgeable and have past experience in commissioning of mechanical and electrical systems. Submit affidavit confirmation person's qualifications for Departmental Representative's review and approval.
- .3 Construction Commissioning Supervisor to coordinate and oversee all work activities and input required from subcontractors and applicable trades as required to make equipment, subsystems and system ready for commissioning and to conduct commissioning duties assigned to the Contractor.
- .4 Construction Commissioning Supervisor shall:
  - .1 Be the main point of contact, representing the Contractor, with whom the Commissioning Agent and Departmental Representative will to deal with in matters relating to commissioning.
  - .2 Attend all commissioning meetings and ensure that appropriate persons from subcontractors, trades, suppliers and manufacturers attend meetings when deemed required by Commissioning Agent or Departmental Representative.

1.8 CONTRACTOR'S COMMISSIONING ACTIVITIES

.1 General:

.1 Organize and arrange for the services of subcontractors, their specialists and manufacturer's technical representatives to perform Contractor's commissioning activities.

.2 Ensure that personnel forming part of the Commissioning Team are qualified and knowledgeable of installed equipment and systems and with design intent.

.3 Develop in conjunction with the Commissioning Agent a commissioning schedule as specified in clause 1.11.

.4 Notify Departmental Representative in writing when Facility is ready for be commissioned. Give 14 calendar day notice.

.5 Commissioning will only commence once that full documentation has been received and installed equipment and systems have undergone successful performance verification.

.6 Note that Certificate of Substantial Performance will only be issued when:

.1 All commissioning documentation has been received and found suitable by Departmental Representative;

.2 Designated equipment and systems have been commissioned and;

.3 Training has been completed.

.7 Performance faults:

.1 Equipment and systems found not operating correctly or not performing as intended during commissioning shall be re-verified by checking 100% of all equipment and components of the unfunctional system, including related controls as required to rectify the deficiencies and ensure correct performance.

.2 Costs to conduct additional tests and inspections, as deemed required by Departmental Representative, to determine acceptability and proper performance of such item to be paid for by Contractor.

.2 Prior to Facility being Commissioned:

.1 Submit commissioning documentation as specified in clause 1.13 below.

.2 Submit the Installation/Start-Up Checklist sheets to Commissioning Agent for review prior to conducting the pre-start and start-up of any piece of equipment. Incorporate additional start-up instructions onto checklist as determined by the Commissioning Agent's review.

.3 Conduct the pre-start and start-up of all equipment by following and filling out the approved Installation/Start-Up Checklists.

.4 Conduct Performance Verification on all installed equipment and systems. Use and fill out the PV Report Sheets provided.

.5 Upon completion of start-up and performance verification process, submit signed copy of Checklist and PV sheets to Commissioning Agent as affidavit that required checks and tests were successfully conducted.

.6 Record performance measurements and data reading on PV sheets and return to Commissioning Agent for compilation.

- .7 Give Departmental Representative and Commissioning Agent a minimum of 5 days notice for start-up and performance verification of equipment and systems which must be witnessed by Commissioning Agent as determined by Commissioning Agent beforehand on PV sheets.
- .8 Provide missing information and data as identified by Commissioning Agent and Departmental Representative during documentation review.
- .9 Submit above noted documentation before Commissioning will proceed.
- .10 Address deficiencies in Work identified during performance verification of equipment and systems. Conduct additional performance verification thereafter.
- .11 Arrange for special tools and devices, identified at commissioning meeting(s), as deemed required to assist with commissioning.
- .12 Provide access ladders, two way radios and other equipment required by Team when facility will be commissioned.

.3 When Facility is being Commissioned:

- .1 Provide qualified tradespersons to be present at site to assist Commissioning Agent for the time period and commissioning activity specified.
- .2 Assist in commissioning mechanical systems specified.
  - .1 Operate designated building component, mechanical/electrical equipment and system under all modes of operation and conduct checks and tests as directed by Commissioning Agent.
  - .2 Check and verify that building component, equipment, systems and intergrated systems, including their controls, are functioning and responding correctly and interactively with each other.
  - .3 Test systems independently and then in unison with other related systems.
  - .4 Conduct all Commissioning checks and tests in presence of and witnessed by Commissioning Agent and Departmental Representative.
  - .5 Assist Design Consultant and other members of the commissioning team who will also be present to commission Facility.
- .3 Specific procedures used to commission Facility will be provided by Commissioning Agent which includes:
  - .1 Sequential order of building component and system to be tested.
  - .2 Running systems under various anticipated modes and demands (example: high and low cooling or heating loads, duplicating outside temperature conditions, fire alarm and power failure conditions etc.).
  - .3 Running building controls through all sequences of operation to verify and confirm that equipment and systems are responding as designed and intended.
  - .4 Operating designated equipment at peak capacities, recording output data against design criteria.
- .4 Run component or systems as long as necessary to effectively commission all items as deemed required by Commissioning Agent and Departmental Representative.
- .5 Monitor equipment and system responses.
- .6 Record test results, measurements and other data on commissioning forms provided by Commissioning Agent.

.7 Assist in analyzing results. Identify system deficiencies and components not responding as intended.
.8 Correct deficiencies and system non-conformance issues. Adjust, calibrate or fine tune system components as required. Debug system software as may be required.
.9 Retest systems when directed to confirm compliance.

.4 Upon completion of Facility Commissioning:
.1 Provide training to maintenance & operational personnel as specified in clause 1.12 below.
.2 Turn over any filled-in checks sheets or reports resulting from commissioning.

.5 During Warranty period at Occupancy Stage:
.1 After 10 months has elasped from the commencement of the warranty period, conduct commissioning checks on the system:
.2 Fine tune components, systems and intergrated systems and continue system debugging to optimize Facility performance.
.3 Rectify warranty issues.
.4 Submit written report to Commissioning Agent and Departmental Representative.
.1 Indicate results noted and corrective action taken.
.2 Note improvements made to operating parametes and control settings.
.3 Recommend modifications deemed advisable to improve performance, environmental conditions, energy consumptions and other issues.
.5 Commissioning Agent and other team members as determined by Departmental Representative to be present during such work.

1.9 COMMISSIONING ACTIVITIES OF OTHER TEAM MEMBERS

.1 Commissioning Agent:
.1 Represents the Departmental Representative during the commissioning process.
.2 Coordinates activities of the commissioning team members to ensure that commissioning activities are carried out properly and in a timely manner.
.3 Prepares commissioning schedule in concert with Contractor.
.4 Chairs commissioning meetings.
.5 Works with Contractor, subcontractors, equipment suppliers, Design Consultant resources, PWGSC and Tenant Representatives to resolve technical problems which may arise during the process.
.6 Witnesses Contractor's pre-start, start-up and performance verification procedures for certain equipment and systems specified when deemed required due to their critical nature and function in the Facility.
.7 Verifies that Installation/Start-up Checklists and Performance Verification checks and tests are used and stringently followed by Contractor.
.8 Assists Contractor in coordination of training activities for facility staff.
.9 Submits final commissioning report to Departmental Representative.

.2 Design Consultant:
.1 Prepares in concert with Commissioning Agent the Commissioning Plan.

.2 Reviews Contractor's Installation/Start-up Checklists for completeness, incorporating supplement data not addressed on checklist. Provides to Contractor checklist for products which manufacturer does not provide installation and start-up instructions.
.3 Develops performance verifications report sheets for use by Contractor to record actual data and measurements against design data criteria.
.4 Includes, on performance verification report sheets, design data and anticipated performance values for equipment and systems to undergo verification.
.5 Compiles commissioning documentation submitted by Contractor. Prepares final Building Management Manuals.
.6 Assists Commissioning Agent in witnessing pre-start, start-up and performance verification activities.
.7 Approves type and method of calibration for instruments used by Contractor to conduct performance verification and commissioning tests.
.8 Assists Commissioning Agent in reviewing and analysing tests results.
.9 Participate in the training sessions provided by Contractor to tenant O&M staff by giving introductory information on design philosophy, design intent and systems designs,
.10 Assist in the resolution of issues relating to commissioning.

.3 Tenant Representative:
.1 Participates with other team members to ensure that systems as installed meet the operational and functional requirements.
.2 Periodically attends commissioning meetings as required.
.3 Attends final commissioning activities.
.4 Assists in resolving technical problems by providing additional details on operational requirements.

.4 Facility Operations and Maintenance Staff:
.1 Participates in the commissioning process to obtain early introduction to the facility systems and to provide early operator feedback.
.2 Prime interest is in the familiarization and training of appropriate maintenance staff.
.3 Staff may attend certain critical equipment start-up and performance verification activities and provide comments and practical suggestions on issues which may arise during actual operation, maintenance and repair of the equipment and systems.
.4 Attends commissioning meetings periodically, depending on issues being discussed.
.5 Identifies the appropriate staff which must receive the O&M training.

1.10 COMMISSIONING MEETINGS

.1 General briefing on commissioning will be conducted at first project construction meeting at commencement of work.
.1 Issues discussed will include scope and extent of commissioning and clarify responsibilities of commissioning team members.
.2 All team members must attend, including subcontractors of equipment and systems to be commissioned.

.2 Include commissioning as one agenda item at each construction meeting held and chaired by Contractor during construction. Give subject due consideration for each material and equipment supplied and for all matters of Work.

.3 At the 60% construction completion stage, as determined by Departmental Representative, a separate commissioning scope meeting will be called by Departmental Representative to review progress of work, discuss schedule of equipment start-up activities and prepare for upcoming commissioning. Issues at meeting will include:
- .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
- .2 Determine the degree of involvement of each trade and manufacturer's representatives in the commissioning process.

.4 Separate commissioning meetings will be held from the 60% construction stage to project completion. Meetings are tentatively scheduled to be held on a bi-monthly basis but may be more frequent during the equipment start-up and functional testing period.

.5 Whenever possible meetings will be held immediately following the construction meetings.

.6 Ensure that all subcontractors and relevant manufacturer representatives are present at the 60% commissioning scope meeting and at other meetings as deemed required.

1.11 COMMISSIONING SCHEDULE

.1 Address commissioning activities within the construction work schedule. Clearly identify allocated time period for commissioning and training activities.

.2 Provide a separate independent commissioning schedule at the 60% construction stage in order that specific issues and individual details of commissioning can be reviewed, discussed and dealt with from that period onward to project completion. Submit monthly updates thereafter,

.3 Develop commissioning schedule in conjunction with Commissioning Agent. Indicate allocated time period and anticipated dates for:
- .1 Submission of commissioning documentation, including O&M Manuals.
- .2 Equipment and system start-up and performance verification, making them ready to be commissioned.
- .3 Allocated period to commission designated building components and systems.
- .4 Training period.
- .5 Work during Warranty period.

.4 Submit schedule to Departmental Representative for review.

1.12 TRAINING

.1 Commence process of familiarizing Tenant and O&M personnel in the early stages of work on purpose and operation of various equipment and systems. Continue process throughout the entire construction duration.
   .1 Provide informal briefings during occasional site visits, at planned commissioning meetings and during the final commissioning site activities.

.2 Conduct formal demonstration and training sessions only after all identified systems have been commissioned by Commissioning Agent and Departmental Representative has given approval to proceed with the training process.

.3 Provide training and demonstration on equipment, sub-systems, systems and integrated systems.

.4 Carryout training in accordance with requirements of section 01 79 00.

.5 Submit written agenda of training session(s) 4 weeks beforehand for review by Commissioning Agent and Departmental Representative.

.6 Coordinate content with Commissioning Agent. Design Consultant will provide introductory presentation giving general outline of each system design and intended function.

.7 Submit training manuals for review 2 weeks prior to actual training.

.8 Ensure required tools and O&M Manuals are on site for training and system demonstration.

.9 As a minimum, the training sessions to cover the following information:
   .1 Introduction.
   .2 Description of the system with factory personnel being involved at appropriate times.
   .3 Instructions on start-up procedures including seasonal procedures, system check-lists and emergency procedures.
   .4 Operational procedures, including occupancy considerations, seasonal change-over, manual and automatic operations and emergency modes.
   .5 Instruction on system shutdowns, including checklists.
   .6 Instructions on all aspects of system maintenance, including routine servicing, lubrication, overhaul and factory servicing.
   .7 Information concerning the scope of warranties and their use.
   .8 A description of spare parts in stock and their service.
   .9 A description of normal tools required for servicing the systems/equipment.

.10 Submit typewritten record of training sessions given and list of attendees. Use forms of format approved by Departmental Representative.

1.13 COMMISSIONING DOCUMENTATION

.1 Submit the following documentation for use during commissioning and for incorporation thereafter into a Building Management Manual (BMM):
  - .1 Operations and Maintenance Manuals, Project Record Documents and other data as specified in Section 01 78 00. Data to include:
    - .1 Equipment Product Information (PI Data) complete with:
      - .1 Nameplate info.
      - .2 Installation instructions.
      - .3 Operating procedures and
      - .4 Maintenance guidelines.
    - .2 Reviewed shop drawings.
    - .3 As-built record drawings and Specifications.
  - .2 Completed Installation/Start-up Checklist sheets used.
  - .3 Performance Verifications checks and tests procedures and completed report sheets used.
  - .4 Copy of any static and dynamic test and reports conducted.
  - .5 TAB report and other reports as specified in various trade sections.

.2 Above documentation is required by Commissioning Agent to commission Facility. Submit data minimum 3 weeks before commencement of commissioning.

.3 Documentation to include detailed information and number of copies as specified for maintenance manuals of section 01 78 00.

.4 Commissioning Agent and Design Consultant will compile above documentation and produce a BMM manuals for operation/maintenance staff and tenant use.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section covers items common to all sections of Division 21, 22, 23 and 25.

.2 The word “provide″ shall mean ″Supply and install″.

.3 Provide materials, equipment and plant of specified design quality and of current models with published ratings for which replacement parts are readily available.

.4 The codes and standards referred to in the specifications establish the minimum requirements only. The most stringent requirements of the specifications, drawings, codes and standards shall govern. Refer to the latest editions of all applicable codes and standards.

.5 Where indicated on plans, NPS refers to nominal pipe size in standard English units. Otherwise plans are in metric units.

1.2 EQUIPMENT LIST

.1 Complete list of equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

.2 Submit for approval within 10 days after award of contract.

.3 The successful bidder of this contract shall take possession of the above mentioned equipment and install and commission equipment as per specifications.

1.3 AS INDICATED

.1 Means that the item or items specified are shown on the drawings.

1.4 EQUIPMENT INSTALLATION

.1 Unions or flanges: provide for ease of maintenance and disassembly of equipment.

.2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.

.3 Equipment drains: pipe to floor drains.

.4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

.5 Provide shut-off valves on piping connections to all equipment.

.6 Provide 3-valve by-pass on all control valve and pressure reducing valves.

1.5 ANCHOR BOLTS AND TEMPLATES

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

1.6 TRIAL USAGE

.1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Trial usage to apply to following equipment and systems:
.1 Air Systems
.2 Hot Water Heating System
.3 Fire Protection Systems
.4 Compressed Air Systems
.5 Plumbing Systems
.6 Fume Hood Exhaust systems
.7 General Exhaust Systems

1.7 PROTECTION OF OPENINGS

.1 Protect equipment and systems openings from dirt, dust and other foreign materials with materials appropriate to system.

1.8 ELECTRICAL

.1 Electrical work to conform to Division 26 including the following:
.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
.3 Coordinate with Division 26 to ensure that all controlled equipment is correctly connected for operation in accordance with plans and specifications, including supplying all necessary electrical interconnection information and location.
.4 Review all sections of Division 25 for electrical wiring requirements which are the responsibility of this Contractor and not Division 26.

1.9 MOTORS

.1 Provide motors for mechanical equipment as specified and as required.

.2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

.3 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.

.4 Motors 373 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575V, unless otherwise specified or indicated.

.5 Do not deviate from specified voltage unless fully coordinated with Division 26 and the Departmental Representative in writing.

1.10 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.

.3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.6 Motor slide rail adjustment plates to allow for centre line adjustment.

.7 Tension belts to manufacturers' recommendations before start-up and after first 100 hours of operation using calibrated belt tensioning gauge. Submit report during TAB and Commissioning period showing the recommended and actual tension on all units.

1.11 GUARDS

.1 Provide guards for unprotected drives. Including drives located inside air handling units accessible through large access doors.

.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 38 mm dia 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.

1.12 EQUIPMENT SUPPORTS

.1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Division
25.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements Structural Steel for Building. Submit structural calculations with shop drawings.

.3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm high and 50 mm larger than equipment dimensions all around.

.4 Coordinate location of pads with General Contractor.

1.13 SLEEVES

.1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated.

.2 Schedule 40 steel pipe.

.3 Sleeves with annular fin continuously welded at midpoint:
.1 Through foundation walls.
.2 Where sleeve extends above finished floor.

.4 Sizes: minimum 6 mm clearance all around, between sleeve and un-insulated pipe or between sleeve and insulation.

.5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm above other floors.

.6 Fill voids around pipes:
.1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
.2 Where sleeves pass through non-fire rated walls and floor slabs, tightly pack the space between the sleeve and pipe with acoustic filler material and seal both sides with acoustic sealant.

.3 Where sleeves pass through fire rates walls or floors, provide space for firestopping. Pack space between the pipe and sleeve with approved material and seal with approved fire rated and ULC approved sealant. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
.4 Ensure no contact between copper tube or pipe and ferrous sleeve.
.5 Fill future-use sleeves with lime plaster or other easily removable filler.
.6 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.
.7 The mechanical trades will be responsible for placing sleeves or else for costs of core drilling after slabs and walls are constructed.

1.14 PREPARATION FOR FIRESTOPPING

.1 Firestopping material and installation within annular space between pipes, ducts, insulation
and adjacent fire separation: specified.

.2 Uninsulated unheated pipes not subject to movement: no special preparation.

.3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe to move without damaging firestopping material.

.4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.

1.15 ESCUTCHEONS

.1 Provide on pipes passing through walls, partitions, floors and ceilings in finished areas and in Mechanical Rooms.

.2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.

.3 Outside diameter to cover opening or sleeve.

.4 Inside diameter to fit around finished pipe.

1.16 TESTS

.1 Give 72h written notice of date for tests.

.2 Insulate or conceal work only after testing and approval by Departmental Representative.

.3 Conduct tests in presence of Departmental Representative. Re-test if test fails.

.4 Bear costs including retesting and making good.

.5 Piping:
  .1 General: maintain test pressure without loss for 4 h unless otherwise specified.

  .2 Hydraulically test hydronic piping systems at 1-1/2 times system operating pressure or minimum 860 kPa, whichever is greater.
  .3 Test drainage, waste and vent piping to National Building Code and authorities having jurisdiction. Hold 3m standing water column for four (4) hours with no drop in water level. Do not backfill until test is passed.
  .4 Test domestic hot, cold and recirculation water piping at 1-1/2 times system operating pressure or minimum 860 kPa, whichever is greater.
  .5 Test fire systems in accordance with authorities having jurisdiction and as specified elsewhere. Equipment: test as specified in relevant sections.
  .6 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.
  .7 Conduct all other tests as specified in other sections of Division 21, 22, 23 and 25.
  .8 Test steam and condensate systems to 860 kPa.

1.17 PAINTING

.1 Paint all required mechanical work to standard of Section 01 10 10 - Painting. Cost to be borne by Division 01.

.2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.3 Prime and touch up marred finished paintwork to match original.

.4 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.18 SPARE PARTS

.1 Furnish spare parts in accordance with Section 01 78 00 – Closeout Submittals and as follows:
  .1 One set of packing for each pump.
  .2 One casing joint gasket for each size pump.
  .3 One glass for each gauge glass.
  .4 One set of belts for each piece of machinery.
  .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
  .6 Sprinklers and tools per NFPA-13.
  .7 Spare filters for water treatment equipment.
  .8 One spare air valve for each size.

1.19 SPECIAL TOOLS

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 – Closeout Submittals.
  .1 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.20 ACCESS DOORS

.1 Supply access doors for installation in floors, walls or ceilings for access to concealed mechanical equipment for operating, inspecting, adjusting and servicing. Also supply and arrange for installation of access pits and covers for servicing and inspection of valves, devices which are to be installed below grade or below floor in floor slab.

.2 Flush mounted 600 x 600 mm for body entry and 300 x 300 mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

.3 Material:
  .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Departmental Representative.
  .2 Remaining areas: use prime coated steel.

.4 Installation:
  .1 Locate so that concealed items are accessible.
  .2 Locate so that hand or body entry (as applicable) is achieved.
  .3 Installation is specified in applicable sections.

.5 Acceptable Manufacturer:
  - Zurn

1.21 DIELECTRIC COUPLINGS

.1 General:
  .1 To be compatible with and to suit pressure rating of piping system.
  .2 Where pipes of dissimilar metals are joined.

.2 Pipes NPS 2 and under: isolating unions.

.3 Pipes NPS 2-1/2 and over: isolating flanges.

.4 At radiant ceiling panels brass valves may be substituted for dielectric unions.

1.22 DRAIN VALVES

.1 Locate at low points and at section isolating valves unless otherwise specified.

.2 Minimum NPS 3/4 unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.

1.23 DEMONSTRATION AND OPERATING INSTRUCTIONS

.1 Supply tools, equipment and personnel to demonstrate and instruct Operating and maintenance personnel in operating, controlling, adjusting, Maintenance trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.2 Where specified elsewhere in Division 22, 23 and 25, manufacturers to provide demonstrations and instructions.

.3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.

.4 Instruction in maintenance and operations of the following equipment shall be given by factory trained personnel:
- .1 Energy Management and Control System
- .2 Heating and Cooling Systems
- .3 Ventilation Systems
- .4 Plumbing Systems

.5 Where deemed necessary, Departmental Representative may record these demonstrations on video tape for future reference.

.6 The time specified above does not include time for start-up of systems and equipment.

1.24 OPERATION AND MAINTENANCE MANUAL

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

.2 Operation and maintenance manual to be approved by, and final copies deposited with, Departmental Representative before final inspection.

.3 Operation data to include:
- .1 Control schematics for each system including environmental controls.
- .2 Description of each system and its controls.
- .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
- .4 Operation instruction for each system and each component.
- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.

.4 Maintenance data shall include:
- .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
- .2 Data to include schedules of tasks, frequency, tools required and task time.

.5 Performance data to include:
  .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
  .2 Equipment performance verification test results.
  .3 Special performance data as specified elsewhere.
  .4 Testing, adjusting and balancing reports as specified.

.6 Approvals:
  .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless so directed by Departmental Representative.
  .2 Make changes as required and re-submit as directed by Departmental Representative.
  .3 Submit draft copies of Operation and Maintenance Manual at completion of Shop Drawing Phase.

.7 Additional data:
  .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.25 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and other Submittal Procedures.

.2 Shop drawings and product data shall show:
  .1 Mounting arrangements.
  .2 Operating and maintenance clearances. eg. access door swing spaces.

.3 Shop drawings and product data shall be accompanied by:
  .1 Detailed drawings of bases, supports, and anchor bolts.
  .2 Acoustical sound power data, where applicable.
  .3 Points of operation on performance curves.
  .4 Manufacturer to certify as to current model production.
  .5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 33 00 - Shop Drawings and other Submittal Procedures: use MCAC ″Shop Drawing Submittal Title Sheet″. Identify specification section and paragraph number.

.5 Submit shop drawings in complete sets (i.e. all plumbing fixtures at once; all fans at once, etc) and clearly identify which ruling point or particular product is being supplied.

.6 All shop drawings to be in metric. No exceptions. Material that is submitted in Inch-Pound units will be returned marked "Not Reviewed".

1.26 EXISTING SYSTEMS

.1 Connections into existing systems to be made at time approved by Departmental Representative. Request written approval of time when connections can be made.

.2 Be responsible for damage to existing plant by this work.

1.27 CLEANING

.1 Clean mechanical (building) systems in accordance with Section 01 74 00 - Cleaning.

.2 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

.3 In preparation for final acceptance, clean and refurbish all systems and equipment and leave in operating condition including replacement of all filters in all air and piping systems.

1.28 AS-BUILT DRAWINGS

.1 Site records:
- 1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing mechanical systems, control systems and low voltage control wiring.
- .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection at all times.
- .5 CAD file will be made available at Contractor's request.

.2 As-built drawings:
- .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
- .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
- .3 Submit to Departmental Representative for approval and make corrections as directed.
- .4 TAB to be performed using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.3 Submit copies of as-built drawings for inclusion in final TAB report.

1.29 PENETRATION OF WALLS AND FLOOR SLABS

.1 Wherever pipes and ducts penetrate non-fire rated walls and floor slabs, tightly pack the space between construction and ducts/pipes the full depth with acoustic filler material and seal both sides with acoustic sealant. Where pipes pass through fire rated walls and floor slabs, pack space between the pipe and sleeve with approved fire rated and ULC approved material and seal with approved fire rated and ULC approved sealant.

.2 Acoustic Filler:
- .1 Filler material shall be glass fibre or inorganic mineral.
- .2 Filler material shall not have higher combustion rating than the following:-
  - Flame Spread Rating = 25
  - Smoke Development Rating = 0
  - Fuel Contribution Rating = 0

.3 Acoustic Sealant:
- .1 Concealed Application:
  - .1 Non-shrinking, non-straining, non-drying and permanently elastic type.
  - .2 Acceptable Manufacturer:
    - .1 Tremco Acoustical Sealant
- .2 Exposed Application:
  - .1 Permanently elastic, paintable acoustic sealant, latex acrylic or acrylic latex type.
  - .2 Acceptable Manufacturer:
    - Pecora AC-2

1.30 SITE SERVICES

.1 Known Services:
- .1 Conform to drawings, they represent approximate location of known existing underground facilities.
- .2 Discuss with Departmental Representative before starting work and follow his written instructions.
- .3 Carry out test digs before beginning major work. Be responsible for all damage thereto during excavation work and for the cost of all repairs and replacements made necessary thereby.

.2 Unknown Services:
- .1 Avoid damaging or displacing existing services where exact position is not known, but should any damage occur, advise Departmental Representative in writing for instructions as to repairs.

1.31 DRAWINGS

.1 Mechanical drawings are not intended to show structural details or architectural features.

.2 The mechanical drawings are not to be scaled.

.3 Except where dimensioned, indicate general mechanical layouts only. Because of the small scale of mechanical drawings, it is not possible to show all offsets, fittings and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves and accessories which are required to meet the conditions.

1.32 EXISTING SITE CONDITIONS

.1 The contractor shall visit the site of the building in order to examine first hand the existing conditions which may affect his contract. No compensation shall be considered for additional expenditures incurred later through failure to do so.

1.33 EXISTING SYSTEMS AND SERVICES

.1 The location of existing systems and services as shown on the drawings are approximate only. Ascertain the exact location of these services before commencing with installation. No compensation shall be considered for additional expenses incurred later through his failure to do so.

.2 Any connection to the existing systems shall be made at a time approved by the Departmental Representative. The Contractor shall request for written approval of time when these connections could be made. This Contractor shall be responsible for any damage caused to the existing systems by his crew.

.3 Should existing services be accidentally uncovered and disrupted, make complete restoration immediately and ensure adequate protection to avoid further disruption.

.4 Unless otherwise specified, restore services on which work is performed to original condition.

1.34 INSPECTION ,TESTING AND COMMISSION

.1 Provide all necessary personnel and equipment to demonstrate that all system performances required by this division have been met

1.35 COMMISSIONING

.1 Division 21, 22, 23 and 25 Scope of Work includes for labour and materials necessary to complete Commissioning of Mechanical Systems.

.2 Conduct all tests and measurements described in Commissioning Plan and in Division 21, 22, 23 and 25 Specification. Correct deficiencies and repeat until successful. Commissioning Plan includes commissioning activities for complete system. This contract is responsible only for systems installed under this phase.

.4 Provide documentation of test and measurement results as required by Commissioning Plan and under direction of the Commissioning Agent.

.5 All the major mechanical systems shall be commissioned. Brief description of the commissioning process is as below:

.1 All supply, return and exhaust air systems shall be verified for operation and capacity.

.2 Capacity of all major equipment shall be tested and verified.

.6 The commissioning process will be lead by the Commissioning Agent and the Mechanical Trade Contractor. Mechanical Contractor shall ensure that his Project Manager, TAB and EMCS are present to assist the Commissioning Agent during Commissioning. The responsibilities of the Mechanical Trade Contractor's representative and his sub-contractors are defined below and in the Commissioning Plan:

.1 Mechanical Trade Contractor shall be responsible for operation of the Mechanical Systems during commissioning.

.2 TAB shall assist with measurements of flows, temperatures, air velocities, etc.

.3 Control technicians shall be responsible for starting/stopping the equipment, to make adjustments to EMCS routines and to provide any other EMCS generated data required for commissioning.

1.36 FUME HOOD INSTALLATION AND TESTING

.1 Fume hoods and fume hood fans to be installed and tested as per the requirements of the PWGSC document “Laboratory Fume Hoods, MD15128-2013 Guidelines for Departmental Representatives, Design Professionals and Maintenance Personnel.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for wet pipe fire protection and sprinkler systems for heated areas.

1.2 REFERENCES

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)

.1 ANSI/NFPA 13-2007, Installation of Sprinkler Systems.

.2 ANSI/NFPA 24-2007, Installation of Private Fire Service Mains and Their Appurtenances.

.3 ANSI/NFPA 25-2008, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 Underwriter's Laboratories of Canada (ULC)

.1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

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

.1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in the Province of Nova Scotia, Canada.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Test reports:

.1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals:

.1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals in accordance with ANSI/NFPA 20.

.2 Manufacturer's Catalog Data, including specific model, type, and size for:

.1 Sprinkler heads.

.3 Field Test Reports:

.1 Preliminary tests on piping system.

.4 Records:

.1 As-built drawings of each system.

.1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.

.2 Submit 760 mm by 1050 mm drawings on reproducible Mylar film with title block similar to full size contract drawings.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in wet sprinkler systems with documented experience approved by manufacturer.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 MAINTENANCE

.1 Extra Materials:

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

.2 Provide spare sprinklers and tools as required by ANSI/NFPA 13.

Part 2 Products

2.1 ABOVE GROUND PIPING SYSTEMS

.1 Provide fittings for changes in direction of piping and for connections.

.1 Make changes in piping sizes through tapered reducing pipe fittings, bushings will not be permitted.

.2 Perform welding in shop; field welding will not be permitted.

.3 Conceal piping in areas with suspended ceiling.

2.2 PIPE, FITTINGS AND VALVES

.1 Pipe:

- .1 Ferrous: to ANSI/NFPA 13.
- .2 Copper tube: to ANSI/NFPA 13.

.2 Fittings and joints to ANSI/NFPA 13:

- .1 Ferrous: screwed, welded, flanged or roll grooved.
- .2 Copper tube: screwed, soldered, brazed.
- .3 Provide welded, threaded, grooved-end type fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.
- .4 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
- .5 Fittings: ULC approved for use in wet pipe sprinkler systems.
- .6 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.
- .7 Side outlet tees using rubber gasketed fittings are not permitted.
- .8 Sprinkler pipe and fittings: metal.

.3 Pipe hangers:

- .1 ULC listed for fire protection services in accordance with NFPA.

2.3 SPRINKLER HEADS

.1 General: to ANSI/NFPA 13 and ULC listed for fire services.

.2 Sprinkler Head Type: See Drawings. Sprinklers shall be frangible bulb standard spray quick response type except where noted otherwise.

.3 Provide nominal 1.2 cm orifice sprinkler heads.

- .1 Release element of each head to be of intermediate temperature rating or higher as suitable for specific application.
- .2 Provide polished stainless steel ceiling plates or chromium-plated finish on copper alloy ceiling plates, and chromium-plated pendent sprinklers below suspended ceilings.
- .3 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.
- .4 Provide sprinkler heads as indicated.
- .5 Deflector: not more than 75 mm below suspended ceilings.
- .6 Ceiling plates: not more than 25 mm deep.
- .7 Ceiling cups: not permitted.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install, inspect and test to acceptance in accordance with ANSI/NFPA 13 and ANSI/NFPA 25.

3.3 PIPE INSTALLATION

.1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.

.2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.

.3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.

.4 Inspect piping before placing into position.

3.4 DISINFECTION

.1 Disinfect new piping and existing piping.

.2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.

.3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.

.4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.5 FIELD QUALITY CONTROL

.1 Site Test, Inspection:

- .1 Perform test to determine compliance with specified requirements in presence of Departmental Representative.
- .2 Test, inspect, and approve piping before covering or concealing.
- .3 Preliminary Tests:
  - .1 Hydrostatically test each system at 1379 kPa for a 2 hour period with no leakage or reduction in pressure.

.2 Flush piping with potable water in accordance with NFPA 13.

.3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.

END OF SECTION

Part 1 General

1.1 GENERAL CONDITIONS

.1 Division 1, Division 21, 22, 23 and 25 are both a part of this Section and shall apply as if repeated here.

1.2 DESCRIPTION OF SYSTEMS

.1 Provide complete plumbing system including:
   .1 Sanitary and vent, hot as shown on the drawings and cold water, compressed air system, including fixtures and equipment, as shown on the drawings.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00.

.2 Clearly indicate roughing-in dimensions and all other physical characteristics pertinent to installation.

.3 Shop drawings are required for the following equipment:
   .1 Plumbing fixtures and trim.
   .2 Plumbing specialities.
   .3 Pumps.
   .4 Water heaters.

.4 Submit shop drawings only on materials and equipment specified or approved by Departmental Representative.

1.4 MAINTENANCE DATA

.1 Provide maintenance data in English and French for incorporation into maintenance manual specified in Section 01 78 00 – Closeout Submittals.

1.5 FIXTURES AND FITTINGS

.1 In case of discrepancy between architectural and mechanical drawings as to number and location of fixtures the architectural drawings shall govern.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ANSI B16.15-1985, Cast Bronze Threaded Fittings, Classes 125 and 250.

.2 ANSI B16.18-1984 Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ANSI B16.22-1995, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.4 ANSI B16.24-1998, Bronze Pipe Flanges and Fittings, Class 150 and 300.

.5 ASTM B88-99, Specification for Seamless Copper Water Tube.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 01 33 00.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

Part 2 Products

2.1 PIPING

.1 Domestic hot, cold and recirc systems, within building.
  - .1 Above ground: copper tube, hard drawn, type L: to ASTM B88.
  - .2 Buried and embedded: copper tube, soft annealed, type K: to ASTM B88, in long lengths and with no buried joints.

2.2 FITTINGS

.1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI B16.24.

.2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI B16.18.

.4 Wrought copper and copper alloy, solder type: to ANSI B16.22.

.5 Copper mechanical groove coupling.

2.3 JOINTS

.1 Solder/brazing: to contain less than 0.2% lead and to suit application.

.2 Teflon tape: for threaded joints.

2.4 GATE VALVES

.1 NPS 2 and under, soldered/screwed:
- .1 Rising stem: to MSS SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc.
- .2 Acceptable Manufacturer:
  - .1 Crane 428/1324
  - .2 Jenkins 810/813
  - .3 Red & White 293/299
  - .4 Kitz 24 / 43
  - .5 Milwaukee 148/1169
  - .6 Newman Hattersley T607/T609
  - .7 Nibco T-111/S-134

.2 NPS 2 1/2 and over flanged:
- .1 Rising stem: to MSS SP-70, Class 125, 860 kPa, full faced, flanged ends, cast-iron body, bronze trim.
- .2 Acceptable Manufacturer:
  - .1 Crane 465½
  - .2 Jenkins 454
  - .3 Red & White 421A
  - .4 Kitz 72
  - .5 Milwaukee F2885
  - .6 Newman Hattersley 504
  - .7 Nibco F-617-0

2.5 GLOBE VALVES

.1 NPS 2 and under, soldered/screwed:
- .1 To MSS SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet.
- .2 Lockshield handles: as indicated.
- .3 Acceptable Manufacturer:
  - .1 Crane 5/1310
  - .2 Jenkins 106B/106BP
  - .3 Red & White 220/212
  - .4 Kitz 09 / 10
  - .5 Milwaukee 502/1502
  - .6 Newman Hattersley A50/A51
  - .7 Nibco T-211-Y/S-211-Y

2.6 SWING CHECK VALVES

.1 NPS 2 and under, soldered/screwed:
.1 To MSS SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat.
.2 Acceptable Manufacturer:
.1 Crane 37/1342
.2 Jenkins 4092/4093
.3 Red & White 236/237
.4 Kitz 22 / 23
.5 Milwaukee 509/1509
.6 Newman Hattersley A60/A61
.7 Nibco T-413-B/S-433-B

.2 NPS 2 1/2 and over flanged:
.1 To MSS SP-71, Class 125,860 kPa, cast iron body, full faced, flanged ends, regrind/removable seat, bronze disc, bolted cap.
.2 Acceptable Manufacturer:
.1 Crane 373
.2 Jenkins 587
.3 Red & White 435A
.4 Kitz 78
.5 Milwaukee F2974
.6 Newman Hattersley 651
.7 Nibco F-918-B

2.7 BALL VALVES

.1 NPS 2 and under, soldered/screwed:
.1 Class 150.
.2 Bronze body, chromeplated brass, stainless steel, ball, PTFE Teflon adjustable packing, brass gland and PTFE Teflon, Buna N seat, steel lever handle.
.3 Acceptable Manufacturer:
.1 Crane 9302/9322
.2 Jenkins 901A/902A
.3 Red & White 5044/5049
.4 Kitz 68 / 69
.5 Milwaukee BA-100/BA-150
.6 Newman Hattersley 1969/1979
.7 Nibco T-FP600/S-FP600

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with latest National Plumbing Code of Canada and local authority having jurisdiction except where specified otherwise.

.2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.

.3 Assemble all piping using fittings manufactured to ANSI standards.

.4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

.5 Connect to fixtures and equipment in accordance with manufacturer's instructions unless otherwise indicated.

.6 Buried tubing:
  .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
  .2 Bend tubing without crimping or constriction. Minimize use of fittings.

3.2 VALVES

.1 Isolate equipment, fixtures and branches with ball valves.

.2 Balance recirculation system using lockshield globe valves.

3.3 DISINFECTION

.1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction. After testing, provide acceptable water quality test report.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM B32-96, Specification for Solder Metal.

.2 ASTM B306-99, Specification for Copper Drainage Tube (DWV).

.3 CAN/CSA B70-M97, Cast Iron Soil Pipe, Fittings and Means of Joining.

.4 B125-93, Plumbing Fittings.

.5 B158.1-1976 Cast Brass Solder Joint Drainage, Waste and Vent Fittings.

.6 CAN/CSA-B602-M90 Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe.

Part 2 Products

2.1 COPPER TUBE AND FITTINGS

.1 Above ground sanitary and vent Type DWV to: ASTM B306.
- .1 Fittings:
  - .1 Cast brass: to B158.1.
  - .2 Wrought copper: to B125.
- .2 Solder: tin-lead, 50:50, to ASTM B32-89, type 50A.

2.2 CAST IRON PIPING AND FITTINGS

.1 Above and below ground sanitary, storm and vent: to CAN3- B70.
- .1 Joints: Mechanical joints (Above ground).
  - .1 Neoprene sleeve with six (6) band stainless steel clamps.
    - .1 Acceptable Manufacturer:
      - .1 Husky SD 4000 Series
- .2 Hub and spigot (Below ground).
  - .1 Neoprene gasket joints.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with latest National Plumbing Code - of Canada and local authority having jurisdiction except where specified otherwise.

.2 Install piping parallel and close to walls to conserve headroom and space, and grade as indicated.

.3 Install mechanical joint screws torqued to the manufacturer's recommendations.

.4 For storm system ensure all joints are water tight, torqued and tested to 5m water column from below grade to 2nd floor level.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM D4104 – Standard Specification for Propylene Plastic Injection and Extrusion Materials.

.2 ASTM F1412 – Standard Specification for Polyolefin Pipe and fittings for Corrosive Waste Drainage Systems

.3 CAN/CSA B181.3 – Polyolefin Laboratory Drainage Systems.

1.2 SHOP DRAWINGS

.1 Submit Shop Drawings in accordance with Section 01 33 00 – Shop Drawings and Other Submittal Procedures.

Part 2 Products

2.1 PIPING & FITTINGS

.1 Flame-retardant polypropylene Schedule 40 piping with threaded compression joint fittings.
- .1 Acceptable Manufacturer:
  - .1 Watts pHpro
  - .2 IPEX Labline
  - .3 Zurn

.2 Bottle Traps: Polypropylene bottle trap with 1 litre bottle.
- .1 Acceptable Manufacturer:
  - .1 Orion BT1

Part 3 Execution

3.1 INSTALLATION

.1 Above ground piping shall be fire stopped at all fire separations. Method of fire stopping shall be submitted to Departmental Representative for approval.

.2 Ensure all compression joints are adequately tightened to prevent any leakage.

.3 Test complete laboratory drainage and vent systems with water to withstand a 3m head for a minimum of 15 minutes without any leakage.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A181/181m - 95b, Specification for Forgings, Carbon Steel for General Purpose Piping.

.3 ANSI B16.5 - 1996, Pipe Flanges and Flanged Fittings.

.4 ANSI B16.11 - 1996, Forged Steel Fittings, Socket Welded and Threaded.

.5 CSA-B51 - 97, Boiler, Pressure Vessel and Pressure Piping Code.

1.2 SHOP DRAWINGS

.1 Submit Shop Drawings in accordance with Section 01 33 00 – Shop Drawings and Other Submittal Procedures.

Part 2 Products

2.1 PIPING & FITTINGS

.1 Above-ground pipe & fittings - Schedule 80 seamless black steel.

.2 Fittings:
- .1 NPS 2 and smaller: Schedule 80 steel socket welded.
- .2 NPS 2-1/2 and larger: Schedule 80 steel butt or socket welded.
- .3 Couplings: socket welded or threaded half coupling type.
- .4 Unions: 1030 kPa malleable iron with brass to iron ground seat. Use dielectric unions for joining dissimilar metals.
- .5 Flanges: socket welded or threaded half coupling type.
  - .1 NPS 2 and smaller: Forged steel, raised face and socket welded.
  - .2 NPS 2-1/2 and larger: Forged steel, raised face and slip-on or weld neck.

Part 3 Execution

3.1 INSTALLATION

.1 Install flexible connections as specified.

.2 Install shut-off valves at outlets, major branch lines and where indicated on drawings.

.3 Install unions to permit removal or replacement of equipment.

.4 Install tees in lieu of elbows at all changes in direction of piping. Install plug in all open ends of tees.

.5 Grade piping at minimum 1% slope.

.6 Install compressed air trap and pressure equalizing pipe at each moisture collecting point. Drain pipe to nearest floor drain.

.7 Provide drains for compressor and dryer.

.8 Blowout piping to clean interior thoroughly of all oil and foreign matter.

3.2 INSTALLATION

.1 Complete compressed air piping system shall be tested with air to withstand a minimum pressure of 1103 kPa for 4 hours with maximum pressure drop of 10kPa.

END OF SECTION

Part 1 General

1.1 GENERAL INSTRUCTIONS

.1 Read and conform to:
.1 Comply with Division 1 requirements and documents referred to herein.

1.2 DEFINITIONS

.1 Validate: for tests and demonstrations: to witness and validate successful performance demonstration or record deficiencies; to validate after correction successful demonstration; these validations of the tests become references for the Consultants certification.

.2 Certify: for documents including as-built drawings: Review for accuracy and completeness or record deficiencies.

.3 Witness: The Commissioning Agent will observe as required and record summary of test results.

.4 BAS: refers to the Building Automation System (Similar terms are: EMCS)

.5 TAB: Testing and Balancing for system verification.

.6 Commissioning Agent: Commissioning Agent in charge of the commissioning process and recommends final acceptance. The consultant will act as the commissioning Agent for this project.

.7 Independent Third Party Agent: Independent agent specialized in installation and testing of the system and retained by the Contractor or Departmental Representative.

1.3 REFERENCES

.1 CSA B149-00 - Installation Code for Gas -Burning Equipment.

.2 NFPA 13 - Installation of Sprinkler Systems.

.3 NFPA 20 – Centrifugal Fire Pumps.

.4 CSA/NFPA - Smoke Control.

1.4 DOCUMENTS

.1 In case of discrepancies or conflicts between documents, documents will be governed in the order specified in Division 1.

1.5 COMMISSIONING OBJECTIVES

.1 Objectives of commissioning process are:
.1 To support quality management through monitoring and checking of installation;

.2 To verify system performance through testing and commissioning of completed installation;

.3 To move completed facility from “static completion” state to optimal “dynamic” operating state;

.4 To transfer facility from Contractor to Departmental Representative in such a manner that provision of a quality facility to Departmental Representative has been assured.

.5 To optimize operating and maintenance through delivery of comprehensive quality training and instruction to Departmental Representatives operating personnel.

.6 To assure provision of accurate and useful historical records, such as, as-built drawings, test certificates, etc. to Departmental Representative. Such records provide important data for operating and maintaining systems as well as for future system testing, maintenance or renovations and to trouble shoot and repair the components of systems.

.7 To extend commissioning into operational phase in order to verify performance levels under a range of operating conditions; such as change of seasons. This process will help to avoid unforeseen or hidden operating and maintenance expenses that may develop later on.

.8 Monitor operation, performance and maintenance programs; optimize system’s performance under normal operating conditions, partial occupancy, and full occupancy, under the direction and review of Commissioning Authority. This phase lasts throughout warranty period. It may, however, involve activities to ensure completion of:

  .1 System debugging and optimization.

  .2 Completion of training and instruction for operating and maintenance personnel.

  .3 Completion of all commissioning activities on defective, seasonally-sensitive systems, for varying modes and periodic simulated emergency conditions.

.9 Commissioning shall be considered complete when all of the objectives of commissioning, as specified herein, have been achieved.

1.6 COMMISSIONING MEETINGS, SCHEDULING, AND REPORTING

.1 Contractor shall include the commissioning plan in their construction schedule and shall schedule for all tests and equipment start-up in the construction schedule.

.2 Commissioning meetings shall be scheduled as required. The meetings shall address commissioning related responsibilities as well as all specified testing, documentation, O&M manuals, training, and post construction requirements. The testing schedules and results of all tests shall be reviewed at the meetings.

.3 Where construction may be completed in phases, allow for the frequency of meetings to correspond to the varying stages of construction of each phase.

.4 The Contractor shall attend commissioning meetings at regular intervals, as called by the Commissioning Agent

.5 The Contractor shall schedule work to include specified Commissioning related tasks. Cooperate with the Departmental Representative's Commissioning Agent, and coordinate subtrades as required, to successfully demonstrate and verify commissioning related tests.

.6 The Contractor shall schedule work to include specified Commissioning related testing prior to Departmental Representative's demonstration and Departmental Representative's training.

.7 Testing forms and reports associated with the mechanical systems shall be directed to the Consultant, to the Departmental Representative, and to the Commissioning Agent.

.8 The forms and reports to be issued shall include:
- .1 Shop drawings, issued and accepted;
- .2 Equipment verification forms;
- .3 Testing forms;
- .4 Reports resulting from tests;
- .5 Testing schedule;
- .6 Minutes of commissioning meetings.

1.7 WARRANTY

.1 Involvement of Commissioning Agent. does not void any guarantees or warranties nor does it relieve Contractor of any contractual responsibilities.

1.8 RESPONSIBILITIES Commissioning Agent

.1 Responsibilities of Commissioning Agent. are as follows:
- .1 Design Phase:
  - .1 Participate in design team meetings. Obtain Departmental Representative's requirements and Consultants philosophy and intent and expected system performance. This will form the basics of the testing and commissioning documents.
  - .2 Provide input and feedback to design team with emphasis on testing, commissioning, operation and maintenance of the proposed system and equipment.
  - .3 Provide commissioning document to form part of the Bid documents.

- .2 Construction Phase:
  - .1 Review Contractor's approved shop drawing submission for commissioning related issues.
  - .2 Prepare commissioning plan based on the contractor's schedule and installation method statement;
  - .3 Monitor, check and inspect the installation throughout the construction stages.
  - .4 Supervise the commissioning, including scheduling.
  - .5 Issue deficiencies reports noting any issues that may have an impact on the commissioning of the equipment or system.
  - .6 Attend construction site meetings as required to discuss commissioning related items and any impact on Project schedule.
  - .7 Set-up and chair commissioning meetings.

.8 Witness and validate tests as required; note deficiencies and issue progress reports.
.9 Work with the project team to expeditiously resolve any problems that may arise due to site conditions.
.10 Prepare Systems Operating Manual.
.11 Co-ordinate with Departmental Representative, training and instructions provided by Contractors, manufacturers and Suppliers.

.3 Post-Construction Phase:
.1 Prepare final report on commissioning, identifying any deficiencies that may be outstanding.
.2 Recommendation of any additional training and/or instruction of operating and maintenance personnel deemed necessary over and above that already provided.
.3 Complete system checks with Contractor:
.1 Once during the first month of building operation.
.2 Once during the third month of building operation.
.3 Once between the fourth and tenth months in a season opposite to the first or third month visit.

1.9 RESPONSIBILITIES OF DEPARTMENTAL REPRESENTATIVE

.1 Responsibilities of Departmental Representative are as follows:
.1 To provide operating personnel to attend training and instruction regarding specific components, equipment and systems.
.2 To retain the services of independent third parties for system verification and certification as required in the document or by applicable codes.
.3 To observe on-site installation, start-up and testing equipment and systems.

1.10 RESPONSIBILITIES OF CONSULTANT

.1 Responsibilities of Consultant areas follows:
.1 Review contractor’s shop drawings submission to ensure that the equipment proposed comply with specifications requirements;
.2 Review contractor’s installation program to ensure that the installation sequences have been coordinated with the project schedule;
.3 Monitor, check and inspect the installation throughout the construction stages to ensure the equipment installation is as approved and the installation method, workmanship, procedures will follow the approved submission and method statement;
.4 Inspect the systems installation and issue deficiencies reports. Ensure deficiencies are corrected and certify installation of systems;
.5 Review contractor’s commissioning plan to ensure the proposed tests, the sequences and method of tests conform to the contract requirements; the testing and commissioning sequences coincide with the project schedule;
.6 Review operating and maintenance manuals, balancing and test reports and as-builts for accuracy;
.7 Witness tests; note any deficiencies and provide progress report;
.8 Certify completion of contractor’s commissioning.

1.11 RESPONSIBILITIES OF CONTRACTOR

.1 Responsibilities of Contractor are as follows:

- .1 Construction Phase:
  - .1 To manage and ensure entire installation comply with requirements of the Contract Documents;
  - .2 Submit shop drawings complete with Contractor's Stamp of Review;
  - .3 Submit working detail (interference or installation) drawings, as required;
  - .4 The Contractor shall coordinate with the Commissioning Agent to prepare the Construction Commissioning Plan.
  - .5 Complete commissioning data test forms;
  - .6 Submit installation method statement. This generally includes:
    - .1 Method of equipment delivery to the installation location on site;
    - .2 Prerequisite preparation for delivery, such as completion of the factory testing and the completion of site work to accept this equipment;
    - .3 Installation method and sequences of installing the equipment and the associated connections to the equipment;
  - .7 Submit an installation schedule. This schedule shall include:
    - .1 Time schedule of each activity, with lead and lag time allowed and indicated;
    - .2 Shop drawings and working detail drawings submission;
    - .3 Major equipment delivery and factory testing date;
    - .4 Coordinated installation activities and sequences in compliance with the Construction Manager's project schedule and other trade's installation schedule;
    - .5 Schedule of testing and commissioning of the systems and major equipment;
  - .8 Submit a commissioning schedule. This schedule shall include:
    - .1 Time schedule for system and equipment commissioning which are in compliance with the timing and sequences of installation schedule stated above. In this schedule allow for additional time for testing and commissioning, such that re-test of the equipment can be performed in a timely manner if required without impacting the overall project schedule or cause delay to Project completion;
    - .2 Dates for completion of required factory tests prior to equipment delivery to the site shall be indicated in the schedule;
    - .3 Prepare and submit testing and commissioning method statements for review and approval;
    - .4 Prepare and submit testing and commissioning record or report forms for review and approval;
  - .9 Attend progress and commissioning meetings;
  - .10 Promptly rectify or replace reported deficiencies and defects;
  - .11 Where required by codes and/or specification, retain manufacturers and/or independent third parties to provide service for testing and certification of the systems and training of Departmental Representative's personnel;
  - .12 Provide training and instruction to the Departmental Representative's operating personnel;

.13 Perform testing and commissioning of equipment and systems to the satisfaction of the Consultant and Commissioning Agent. as stated in approved schedule and method described above. Testing and commissioning will be witnessed by the Commissioning Agent. as required. Contractor or his retained agents shall also record procedure and findings in approved test and record forms. Submit test and record forms with the signature of the tester for review and approval to the Consultant and Commissioning Agent.;

.14 Pay for and be responsible for all inspections required by codes, specification and Authorities having Jurisdiction. Obtain and submit all Certificate of Approval for such inspections and verifications;

.15 Submit for review as-builts drawings including those for location of control devices and wiring and operating and maintenance manuals for each piece of equipment as per the specification requirements;

.16 Provide Operating and Maintenance Manuals for review by the Consultant and Commissioning Agent. with all the testing and commissioning results and reports incorporated;

.17 Obtain, issue and assign warranties for equipment and systems to the Departmental Representative;

.18 Provision of all necessary test equipment shall be the responsibility of the contractor. Provide recently validated calibration certificates for all equipment to be used for verification prior to testing and commissioning commencement.

.2 Post-Construction Phase:

.1 Optimize operation according to occupant’s needs, using the System Operation Manual prepared by the Commissioning Agent. as reference points;

.2 Complete all commissioning procedures and activities and performance verification procedures which were delayed or not concluded during the commissioning phase;

.3 Complete system checks:

.1 Once during the first month of building operation;

.2 Once during the third month of building operation;

.3 Once between the fourth and tenth months in a season opposite to the first or third month visit;

.4 Complete rectification of all deficiencies revealed by these checks. Equipment manufacturers involved in commissioning shall participate in systems checks.

.5 Revise all “as-built” and operating and maintenance documents to reflect all changes, modifications, revisions and adjustment upon completion of commissioning;

.6 Schedule a question and answer session for the operating and maintenance personnel 3 months after handover of the facility to the Departmental Representative’s. The duration of this session or sessions will be dictated by the number of questions or concerns that shall be addressed.

1.12 COMMISSIONING INVOLVEMENT

.1 Commissioning Agent. shall direct, witness and validate as required; and Contractor and/or his Suppliers or retained Independent Third Party Agents shall perform the following:
  .1 Check and ensure installation of systems and equipment to ensure installations are completed and in a proper and safe state ready for testing and commissioning;
  .2 Run and test the systems and equipment through their design parameters to verify their capabilities in performance, sequencing, safety protection and alarms annunciation;
  .3 Ensure deficiencies and defects found are rectified and replaced and the systems and equipment re-tested as required;

  .4 Arrange and provide demonstration and training of Departmental Representative's personnel;
  .5 Issue Operating and Maintenance Manuals for systems and equipment;

1.13 SYSTEMS TO BE COMMISSIONED

.1 Mechanical systems shall include but not limited to following:
  .1 Plumbing; potable and non-potable water systems
  .2 Drainage: storm water and sanitary sewer piping system;
  .3 Ventilation system including air handling units, FF-1 an dFF-2 Fume hood fans and G.E. Fan.
  .4 Air distribution systems;
  .5 Noise and vibration;
  .6 Building automation system (New Laboratory Control System).
  .7 New Laboratory supply and exhaust system.

1.14 TESTING EQUIPMENT

.1 Contractor and manufacturer shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Agent. and Consultant for approval.

.2 Mechanical Testing Equipment:
  .1 Following equipment shall be provided but not limited to:
    .1 Pressure measurements: manometers, pressure gauges;
    .2 Velocity measurement: pilot tube, propeller or revolving vane manometer, thermo anemometers, hot wire anemometers;
    .3 Volume or mass flow measurement: venturi, nozzle and orifice flow meter, positive displacement meter;
    .4 Rotational speed: tachometer;
    .5 Sound measurement: electronic sound level meter for acoustic measurement with octave band analysis;
    .6 Vibration measurement: accelerometer;
    .7 Recording: chart recorder;
    .8 Electrical measurements: voltmeter, ammeter and wattmeter.

1.15 DOCUMENTATION

.1 Contractor shall record test results and procedures on approved record forms and submit the forms together with copies of test certificates to Consultant and Commissioning Agent. for review and approval.

.2 When results are validated, Commissioning Agent shall incorporate those records in his System Operating Manual. He shall also make entry of those test results into appropriate sections of the System Operating and Maintenance Manual as reference for future system/equipment performance tests.

1.16 COMMISSIONING PROCESS

.1 Commissioning Agent: to perform and complete all work as specified in the “GENERAL” Section of this specification “Responsibilities of Commissioning Agent”.

.2 Contractors: To perform and complete all works as specified in the “GENERAL” Section of this specification “Responsibilities of Contractor”. In general, it shall include complete activation of all systems; calibration, test, and verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequence of operation; rectification of deficiencies; recording of test results for submission; demonstration, instruction and training of Departmental Representative’s operating and maintenance personnel; follow-up during first year of operation for fine tuning and building service monitoring.

.3 Equipment verification: Contractor shall test and verify proper operation of all equipment and systems prior to start of commissioning and record all results from the test for each piece of equipment. Forms shall be included in the Operating and Maintenance Manual. Equipment data shall include, but is not limited to:
  .1 Manufacturer’s name, address and telephone number;
  .2 Distributors’ name, address and telephone number;
  .3 Make, model number and serial number;
  .4 Pumps - RPM, impeller sizes, rated flow;
  .5 Fans - belt type and size, sheave type and size;
  .6 Electrical - volts, amps, fuse size, overload size;
  .7 Equipment enclosure type;
  .8 Switchboard, panel board - volt, rated current, number of phase and fault rating;
  .9 Any other special characteristics.

1.17 TESTING FOR MECHANICAL SYSTEMS

.1 Plumbing and Drainage System Testing:
  .1 Plumbing and drainage system shall be tested in accordance with the Canadian Plumbing Code.
  .2 Contractor shall notify Building Inspector when systems are available for testing. Contractor shall document all tests performed and shall arrange for Building Inspector to sign for tests completed. Forward forms to Consultant and Commissioning Agent for review.

.3 When the plumbing system has been completed take a sample of the drinking water, in the presence of the Consultant. Forward the sample to a testing laboratory which shall be approved by the Consultant. Forward the test results to the Consultant and Commissioning Agent. Include for all cost of water analysis.

.4 Also perform hydrostatic pressure test and system disinfection for domestic hot and cold water systems.

.2 Water Treatment Systems:

.1 Contractor shall employ a Chemical Treatment Specialist who shall assist the Contractor with selection of the chemical treatment system, inspect the installation and tests the system. Specialist shall complete manufacturers’ testing forms and submit a report to the Consultant.

.2 Specialist shall assist Contractor in cleaning all piping systems. Specialist shall take samples and repeat the cleaning process if specification requirements are not met.

.3 Specialist shall assist Contractor and add chemical immediately after the cleaning process for each system for protection. The specialist shall take samples and repeat the process until specification requirements are met.

.4 Specialist shall revisit the site after 1 month of operation of each system and re-test systems.

.3 Fire Protection System:

.1 Contractor shall hydrostatically test the systems as per the specifications and NFPA requirements to meet all certifications. The tests shall be witnessed. Provide a copy of the report in NFPA 13 and NFPA 14 reporting format for all such test to the Commissioning Agent. Contractor to perform flow-pressure test on water service on Lower Water Street.

.2 Contractor to perform flow, alarm, drain flow and supervision as required.

.3 Contractor to re- commission existing fire pump.

.4 Coordinate interfacing with fire alarm control panel installation specified under Division 16. Perform any other test as required by this specification, and its Supplementary Guidelines and Authorities having Jurisdiction.

.5 Obtain approval certificates from Authorities having Jurisdiction and submit copies of the certificates to the Commissioning Agent for review.

.4 Contractor’s testing of piping systems (applicable to hydronic circulation, domestic hot and cold water, sprinkler piping)

.1 Test all piping systems in accordance with all applicable Plumbing Codes and CSA B149.

.2 All other systems not covered by Codes noted above shall be tested and proven tight over a period of 24 hours by a hydrostatic test. Remove fixtures, appliances, devices, vents and gauges and temporarily plug connections as required. Provide temporary by-pass when required.

.3 Test pressure for water systems (heating/cooling, domestic cold and hot water, sprinkler piping) shall be:

.1 1-1/2 times the system working pressure but not less than 1,035 kPa for a minimum of 2 hours;

.2 Test pressure shall be limited to the maximum working pressure of expansion joints and vibration isolators.

.4 Repair any leaks or defects and repeat the tests to the satisfaction of the Consultant.

.5 After completion of the testing, rough balance the water systems and ensure all coils, converters, etc., are operating approximately to the design conditions to ensure freezing conditions will not occur anywhere. Adjust the circuits by means of the balancing valves.

.6 Where multiple branch lines are installed, the flow in these shall be balanced to ensure hot or cold water, as applicable, at all fixtures.

.7 All tests for the systems shall be witnessed. Complete the testing forms and forward copies of the tests reports to the Consultant and Commissioning Agent.

.8 Co-ordinate with TAB Contractor to ensure all necessary valves required for balancing the system are installed.

.9 Notify Consultant and Commissioning Agent in writing that this co-ordination has taken place before installation begins. If Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to the Departmental Representative.

.10 Ensure all cooling coil drain pans drain freely and that no standing water remains.

.11 Ensure access is provided to all valves and equipment that requires servicing.

.12 Contractor is responsible for all equipment operating to design conditions and shall trim impellers, etc., to provide the required conditions, but is not responsible for the final balancing of the system, which shall be carried out by TAB Contractor.

.13 Contractor shall make available staff at no extra cost to Departmental Representative as required by TAB Contractor, to correct any deficiencies in the mechanical systems which prevent TAB Contractor from balancing the system.

.14 Contractor shall provide copies of all shop drawings requested by TAB Contractor.

.5 The Independent Testing and Balancing Contractor’s balancing of water and glycol hydronic systems:

.1 Contractor shall co-ordinate with TAB Contractor and provide assistance during balancing process.

.2 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.

.3 TAB Contractor shall balance the entire water system to ensure all equipment and systems are operating to design conditions. Adjust the circuits by means of the balancing valves and record the balance positions.

.4 Each pump shall be checked for design, working and shut-off head conditions. Any pump that varies by more than 10% from the design conditions shall have the impeller trimmed or pump changed until design conditions have been met. Contractor shall pay for impeller trimming.

.5 Flow through all heat exchangers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within 10% of manufacturer’s design conditions.

.6 Initial balancing of coils shall be used to ensure that the pressure drops are within 10% of manufacturers’ design conditions. When both the air and water systems are fully operational, entering air and water and leaving air and water readings shall be taken as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Coil water working conditions shall only be taken in conjunction with the air flow working conditions for the coil.

.7 TAB Contractor shall co-ordinate with Contractor to ensure all necessary devices and valves for control and balancing are installed in all necessary locations. Notify Consultant and Commissioning Agent. in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding valves, locations, installation, etc. If TAB Contractor fails to co-ordinate with Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by TAB Contractor at no cost to the Departmental Representative.

.8 TAB Contractor shall not disconnect any direct digital control (DDC) device after it has been calibrated. BAS Contractor shall make all necessary adjustments through the control system as requested by TAB Contractor. If TAB Contractor fails to co-ordinate with BAS Contractor and if failure to co-ordinate results in any cost, the cost of any change required shall be paid for by TAB Contractor at no cost to the Departmental Representative.

.9 TAB Contractor shall co-ordinate with the BAS Contractor and receive instruction regarding set-up, calibration and operation of the DDC as it applies to the TAB Contractor work. The BAS Contractor shall provide the TAB Contractor with a portable operator’s terminal for this work.

.10 TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.

.11 At time of final inspection, recheck, in presence of Consultant and Commissioning Agent, random selections of data recorded in the certified report. Points or areas of recheck shall be selected by Consultant/ Commissioning Agent and shall be a maximum of 30% of the report data.

.12 A measured deviation of more than 10% between the verification reading and the reported data will be considered as failing the verification procedure.

.13 A failure of more than 10% of the selected verification readings will be considered unacceptable and will result in rejection of the report.

.14 In the event the report is rejected, rebalance all systems, submit new certified reports and perform a re-inspection, all at no cost to the Departmental Representative.

.15 Following final acceptance of the certified reports by Consultant, permanently mark the settings of all valves and other adjustable devices so that balance set position can be restored if disturbed at any time. For circuit balancing valves, record the valve position by the number of turns registered on the valve and lock the valve into that position. Do not mark such devices until after final acceptance.

.16 Submit six (6) copies of the final testing and balancing reports to Consultant. Reports shall be complete with index pages and index tabs and certified by TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Consultant.

.17 Submit a copy of the report to Commissioning Agent. for review. Include in the water balancing report: Types, serial numbers and dates and calibration of all instruments used in balancing report.

.6 Contractor’s Testing of Air Distribution Systems:

.1 Contractor shall test for air leakage in accordance with SMACNA Manuals and Standards, all ductwork with the exception of ductwork downstream of variable air volume boxes or other pressure reducing devices. Seal ducts at all equipment

connections and pressurize with a small blower. Test methods and results shall be in compliance with HVAC air duct leakage test manuals of SMACNA. In addition, seal any leaks. Test system as a whole or in parts,
provided all ductwork is accessible for inspection at the time of test. Provide blower, calibrated orifice tube and all test equipment. (The inlet opening of the test blower shall be blocked off before the test blower is started. The inlet opening shall then be opened slowly to prevent over-pressurizing the system). Refer to the specifications for the criteria for leakage evaluation and for the definition of acceptable test results.

.2 Refer to specification Section related to Ductwork and Specialties for pressure ratings of ductwork and systems.

.3 Entire system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions). This section shall make all necessary alterations and repeat the tests until satisfactory operation is achieved.

.4 All tests shall be performed in presence of Consultant. Complete the testing forms and forward to Consultant and Commissioning Agent.

.5 Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to approximately design air quantities, for both maximum and minimum conditions where required, to ensure freezing conditions will not occur.

.6 Co-ordinate with TAB Contractor to ensure all necessary manual dampers and splitter dampers for balancing the system are installed. Notify Consultant in writing that this co-ordination has taken place before installation begins. If this Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to the Departmental Representative.

.7 The testing equipment shall be itemized in the test reports and shall be approved by the Consultant before any tests are undertaken. Calibration of the test equipment must be confirmed and approved by the Consultant before any tests are undertaken.

.8 Ensure access is provided to all fire dampers and equipment that require servicing.

.9 Contractor is responsible for all equipment operating to design conditions and shall change fan sheaves, etc., to provide the required conditions, but is not responsible for the final balancing of the system.

.10 Contractor shall make available staff, as required by TAB Contractor, to correct any deficiencies in mechanical systems which prevent TAB Contractor from balancing system.

.11 Contractor shall provide copies of all shop drawings requested by TAB Contractor. Contractor shall provide access ports for balancing as requested by TAB Contractor.

.7 The Independent Testing and Balancing Contractor’s balancing of air systems:

.1 Contractor shall co-ordinate with TAB Contractor and provide assistance during the balancing process.

.2 Balancing shall not begin until all point to point and BAS component testing has been satisfactorily completed.

.3 TAB Contractor shall balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).

.4 TAB Contractor shall take air measurements, make final adjustments and report upon the air volume at each variable volume box, diffuser, register and grille. Measure the static pressure upstream and downstream of the fan, the fan speed and the motor current.

.5 Measure the return and supply air flow when mixing dampers are set for full outside air and minimum outside air position.

.6 Set the minimum position for the mixing dampers. Co-ordinate with BAS Contractor.

.7 Contractor shall provide new filters, when the final balancing has been completed.

.8 Air volumes measured by TAB Contractor shall be within +5% of those shown on Drawings for diffusers, grilles, registers, variable air volume boxes and fans, at both maximum and minimum volumes shown.

.9 Duct traverse readings shall be taken through access ports. The access ports shall be Duro Dyne IP-1 or IP-2 air tight type. Duct tape is not acceptable.

.10 The insulation or vapour barrier shall be repaired in an approved manner, if damaged.

.11 For variable air volume boxes, TAB Contractor shall verify the minimum and maximum air volumes after the VAV boxes are commissioned by the BAS Contractor.

.12 In all cases where measurements by TAB Contractor show failure to comply with the drawings and specifications, Contractor at no cost to Departmental Representative shall change fan sheaves, etc., as required, and new balancing measurements shall be taken by TAB Contractor.

.13 Ensure all thermostats and controls are set to give the specified conditions and include settings in the report.

.14 Adjust each supply outlet to provide proper throw and distribution in accordance with architectural requirements.

.15 Fans on all systems shall be set-up to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.

.16 Co-ordinate with Contractor to ensure that all necessary manual and splitter dampers for balancing are installed in all necessary locations. Notify Consultant in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding dampers, locations, installation, etc. If TAB Contractor fails to co-ordinate with Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by TAB Contractor at no cost to Departmental Representative.

.17 TAB Contractor shall not disconnect any control device after it has been calibrated. BAS Contractor shall make all necessary adjustments through Building Automation and Controls Systems as requested by TAB Contractor. If TAB Contractor fails to co-ordinate with BAS Contractor and if failure to co-ordinate results in any cost, the cost of any change required shall be paid for by TAB Contractor at no cost to Departmental Representative.

.18 TAB Contractor shall co-ordinate with BAS Contractor and receive instruction regarding set-up, calibration and operation of the DDC as it applies to TAB Contractor work. BAS Contractor shall provide, TAB Contractor, with a portable operator’s terminal for this work.

.19 TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.

.20 At the time of final inspection, recheck in the presence of Consultant and Commissioning Agent random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck would be selected by Consultant/ Commissioning Agent. and shall be a maximum of 30% of the report data.

.21 At the time of verification measure space temperature and relative humidity in a representative number of rooms to verify performance. Tabulate these results and include in certified report as an appendix.

.22 A measured flow deviation of more than 10% between the verification reading and the reported data will be considered as failing the verification procedure.

.23 A failure of more than 10% of the selected verification readings will be considered unacceptable and will result in rejection of the report.

.24 In the event the report is rejected, rebalance all systems, submit new certified reports and re-inspect, all at no cost to Departmental Representative.

.25 Following final acceptance of the certified report by Consultant, permanently mark the settings of all dampers, splitters and other adjustable devices so balance set position can be restored if distributed at any time. Do not mark such devices until after final acceptance.

.26 Submit 6 copies of the final testing and balancing report to Consultant. Reports shall be complete with index pages and index tabs and certified by TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Consultant.

.27 Submit a copy of the report to Commissioning Agent. for review.

.28 Include in balancing report:

- .1 Types, serial numbers and dates of calibration of all instruments used in balancing report;
- .2 Equipment data, manufacturer and model size, arrangement discharge and class, motor type, horse power, voltage, phase, cycles and full load amps. Location and local identification data;
- .3 Fan design data, total volume flow rate, static pressure, motor type, RPM, volts, full load amps and outside air flow rate;
- .4 A complete system schematic with design and actual flow rates at each outlet or inlet. Show room numbers and floors. Duct air quantities: for mains, branches and maximum and minimum for outside air and exhausts, duct size, pressure readings, average velocity, duct recorded flow rates, duct design flow rates. Air inlet and outlets, supply or exhaust outlet identification. Location and number designation;

.29 Manufacturers' catalogue identification and type, of air inlets and outlets application factors, designated area, design and recorded velocities, design and recorded air flow rates, deflector vane of diffusion cone settings.

.30 Refer to Section 15015 – Testing, Adjusting and Balancing (TAB) for further details on TAB requirements.

.8 Testing of HVAC and Specialties Equipment and Systems:

.1 General:

- .1 Contractor shall prepare and submit for approval, Commissioning Plan and schedule which includes:

.1 Detailed schedule for all individual testing activity. The detail shall include the steps to be taken sequentially and indicate which conditions should be observed and recorded;
.2 The status of systems to be able to perform tests;
.3 Required testing equipment;
.4 Manufacturers' commissioning time for all systems and equipment;
.5 Required time for remedial works if necessary;
.6 Staged start-up and commissioning of the systems.

.2 Start-up and test procedures must be consistent with manufacturer's recommendations contained in the Operating and Maintenance Manual.
.3 The start-up report shall record all observations made during the start-up procedures including problems and their resolutions.
.4 Contractor shall retain the services of the manufacturer's technicians to test the equipment and associated systems. Technician shall record the results of the tests on the testing forms. The tests shall be witnessed by Consultant. When tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Consultant. The original shall be inserted into the Operating Manual.
.5 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Consultant and the Commissioning Agent.
.6 Tests which have not been witnessed shall not be accepted and shall be repeated.
.7 Equipment and systems to be tested shall include but not limited to the following wherever applicable:

.1 Plumbing and drainage system including pumps, piping, tanks, etc. ;
.2 Hydronic systems including boilers, chillers, and distribution.
.3 Ventilation system including ductwork, air terminals, fans, etc.
.4 Air handling units;
.5 Heat recovery systems;
.6 Steam humidification system including humidifier, piping, steam accessories, etc.;
.7 Fire protection system
.8 Building automation and controls systems;
.9 Computer room air conditioning systems;

.9 Air Handling System:

1 Air handling units shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on forms provided by manufacturer. The Consultant shall witness the final operational test.
.2 Technician shall verify that the air handling units have been installed according to manufacturer's recommendations, shop drawings and the specification.
.3 Tests shall include verification of electrical power, electrical interlocks, safeties, control, DX compressor, condenser, fans and dampers.
.4 Technician shall start-up the air handling unit and monitor the operation for a minimum of 4 hours of running time after all tests have been completed. Technician shall revisit the site after 1 month of operation and monitor the operation of the system for a minimum period of 4 hours running time. Technician shall issue a report to Consultant after each visit.

.5 Air handling unit manufacturer shall co-ordinate with BAS Contractor to provide the necessary interface to the Building Automation and Controls Systems. Technician shall witness the Building Automation and Controls Systems testing procedure for the air handling unit and sign the testing forms.
.6 Contractor shall rectify any deficiencies identified by TAB Contractor.

.10 Humidification System:
.1 Humidifiers shall be inspected and tested by manufacturer’s technician. Technician shall enter the test results on the forms provided by manufacturer. Consultant shall witness the final operational test.
.2 Technician shall verify humidifiers have been installed according to manufacturer’s recommendations, shop drawings and the specification.
.3 Tests include verification of safeties and control, drains, steam piping and insulation, steam nozzles and distribution.
.4 Technician shall start-up the humidifiers, record and monitor their operation for a minimum of 4 hours running time after the tests have been completed. Technician shall revisit the site after 1 month of operation and monitor the operation of the humidifiers for a minimum period of 4 hours running time. Reports shall be forwarded to Consultant after each visit.
.5 Manufacturer shall co-ordinate with BAS Contractor to provide necessary interface to the Building Automation and Controls Systems. Technician shall witness the Building Automation and Controls Systems testing procedure and control of the humidifiers.

.11 Hydronic Systems:
.1 Pumps and other equipments shall be inspected and tested by manufacturer’s technician. Technician shall enter the test results on forms provided by manufacturer. Consultant shall witness the final operational test.
.2 Technician shall verify heat exchangers and pumps have been installed according to manufacturer’s recommendations, shop drawings and the specification.
.3 Tests shall include verification of safeties and controls.

.12 Building Automation and Controls Systems:
.1 The Building Automation and Controls Systems shall be fully tested and commissioned by manufacturer’s technician to operate in the manner defined by the specifications.
.2 BAS Contractor shall provide a print-out of general and critical alarm lists and all points connected to the Building Automation and Controls Systems. The all point log shall be sub-divided into points per system. One report shall be taken prior to the acceptance test.
.3 TAB contractor to supply their own operating terminal to allow setup and balance of water and air systems.
.4 A point-to-point testing shall be done by BAS Contractor. This test shall include, but is not limited to:
.1 Ensuring that wiring is accurately connected to appropriate terminals;
.2 Checking the function of each control and controlled device (such as the beginning, end and extent of actuator travel);
.3 Connection integrity between actuator and device;
.4 Calibration of sensors;

.5 Output from sensors;
.6 Operation of relays;
.7 Data/information integrity at console;
.8 Remote reset integrity from console to field device;
.9 Interfacing with other systems such as life safety monitoring system.
.10 BAS contractor in conjunction with the mechanical contractor shall create simulated design load conditions for control verification tests.

.5 Testing procedure shall include but is not limited to:
.1 Check and verify that each input point is reporting to the Building Automation and Controls Systems panels and workstations in the normal state and change or state;
.2 Create false alarms at each point and provide a print-out of the test;
.3 Command each output point, via the workstation and verify the action at the device;
.4 Verify that each time of day and optimum start program is operational in software and at the device;
.5 Verify that each program is operational in software and at the device(s);
.6 Verify that each system graphic is dynamically updating;
.7 Test each DDC loop and verify that it is controlling in a stable manner. Create set point changes on output points. False loads shall be introduced to observe the control loops response. Program trend logs at the Building Automation and Controls Systems for a minimum of 30 minutes per control loop with a sampling time of 30 seconds. Provide a print-out of the results. Tune each DDC loop prior to acceptance test. Check each loop again, once during the heating and once during the cooling season and re-tune where necessary;
.8 Verify that each report type is functional;
.9 Verify that each global program that controls more than 1 system is operating;
.10 Verify that all safeties are operating (ie. firestats);
.11 Verify valve and damper actuation;
.12 Verification of the minimum and maximum settings on VAV boxes (if used);
.13 Verify the calibration of each analog input point.

.6 Any sensor disconnected from the input terminal after completion of the performance test shall be retested.

.7 BAS Contractor shall provide a “signed-off” copy of the results of all tests to the Consultant. Acceptance test will not begin until the tests have been reviewed and accepted. Consultant shall witness these tests.

.8 Provide the calibration procedure for each analog sensor. Physically check the calibration of each analog sensor type using a calibrated instrument prior to testing.

.9 When all tests have been completed BAS Contractor shall request the acceptance test procedure shall begin. Consultant shall verify the installation is complete and all tests have been performed and have been successful. BAS Contractor shall then initiate the acceptance test.

.10 The acceptance test period shall be 21 Days. BAS Contractor shall visit the site each morning. Monday to Friday, to review the Building Automation and Controls Systems operation and the building operators log book. The operators log book shall be provided by the BAS Contractor and shall contain all problems experienced by the Custodians. The log shall show the point name and number, time and date of failure and time of return service. During the first 14 Days of the acceptance test, any operational or equipment failures shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 Days of testing, no major failures of any kind will be accepted, or the last 7 Days shall be repeated.

.11 During the acceptance test Contractor shall print out 1 “all-points” log per day. The logs shall be issued to Consultant for review.

.12 BAS Contractor shall set up trend logs and group logs which shall be stored on hard disk for review by Consultant.

.13 System shall not be accepted or considered substantially complete until all tests are completed and approved.

.14 BAS Contractor shall provide a minimum of 2 weeks notice to Consultant prior to testing date.

.15 BAS Contractor shall revisit the site during the first year of operation to review the performance of the Building Automation and Controls Systems. The review shall include DDC loop tuning, sensor calibration, programs, communication, DDC panels, workstations and the operational logs. The visits shall be a minimum of 8 hours each visit. The visits shall be:

.1 Beginning of cooling season;
.2 During the cooling season;
.3 Beginning of heating season;
.4 During the heating season.

1.18 OPERATING AND MAINTENANCE MANUAL

.1 Contractor shall prepare and submit the Operating and Maintenance Manual as detailed in the specification to Consultant 6 weeks prior to beginning of training.

.2 Contractor shall re-submit the manual should the Consultant find deficiencies. Training shall not begin until the manual has been accepted by the Consultant. One copy of the manual shall be forwarded to Commissioning Agent in good quality, vinyl covered binders.

.3 Each Mechanical manual shall be organized as follows, but not limited to following:

.1 A - Project Directory;
.2 B - Plumbing and Drainage;
.3 C - Fire Protection;
.4 D - Heating;
.5 E - Cooling
.6 F - Air Handling Units;
.7 G - Ventilation;
.8 H – Computer Room Air Conditioning Systems;
.9 I - Building Automation and Controls Systems;

.4 Project directory shall contain the names, addresses, fax numbers and telephone numbers of Contractors, Subcontractors, manufacturers and manufacturer’s representatives.

.5 Operating procedures shall be the recommended manufacturer’s operating procedures for the equipment.

.6 Maintenance procedures shall include Scope of Work, frequency of activity, parts required and necessary documentation.

.7 Spare parts list shall be manufacturer’s recommended list for maintenance purposes.

.8 Trouble shooting guide shall be manufacturer’s recommendation for equipment.

.9 Equipment list shall include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes.

.10 Operating and Maintenance Manual shall be submitted to the Departmental Representative in 3 copies.

1.19 SYSTEMS OPERATING MANUAL

.1 The Systems Operating Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.

.2 Systems Operating Manual shall be prepared by Commissioning Agent using data collected by Contractor and test results.

.3 Each section describing a system will contain as a minimum:
- .1 A basic description of the system;
- .2 System location and areas it serves;
- .3 A basic description of operations;
- .4 Electrical services and locations;
- .5 BAS points alarm limits and set points;
- .6 Time of Day schedules;
- .7 A schematic of the system.

.4 Commissioning Agent shall provide a copy of the Systems Operating Manual to Departmental Representative.

1.20 OPERATOR TRAINING AND INSTRUCTIONS

.1 Contractor and equipment manufacturers shall provide operator training for each mechanical system and equipment.

.2 The training and instruction shall be provided by qualified technicians and shall be conducted in a classroom setting at the equipment or system.

.3 Training and instruction will begin when the Operating and Maintenance Manual has been approved and delivered to Departmental Representative.

.4 Each session shall be structured to cover:
- .1 The Operating and Maintenance Manual;
- .2 Operating procedures;
- .3 Maintenance procedures;
- .4 Trouble-shooting procedures;

.5 Manufacturer’s or service representative’s name, address and phone number.

.5 Contractor shall prepare a detailed training and instruction plan. This plan shall include the outline of all sessions and identification of the training presenters.

.6 Submit the plan including a copy of training manual for Commissioning Agent’s review and approval.

.7 Provide course documentation for up to 6 people.

.8 The sessions shall be co-ordinated and videotaped by the Commissioning Agent.

.9 The minimum training and instruction for the Building Automation and Controls Systems shall be 4 Days. The training shall include:
.1 A 1 Day class session at manufacturer’s local office for 2 of maintenance personnel;
.2 A walk-through of the installation for all maintenance personnel to review the installation and equipment;
.3 Operation of the central computer;
.4 Operation of portable terminals;
.5 Control sequences;
.6 Report set-up and generation;
.7 Managing the system;
.8 Maintenance requirements.

.10 Training and instruction requirement for the mechanical system shall include a walk-through of building by Contractor. During the walk-through the Contractor shall:
.1 Identify equipment;
.2 Identify starters associated with equipment;
.3 Identify valves and balancing dampers;
.4 Identify access doors;
.5 Review general maintenance of equipment;
.6 Review drain points in pipework systems;
.7 Identify maintenance items.

.11 When each session has been completed, the Commissioning Agent shall sign to certify completion.

1.21 SYSTEMS DEMONSTRATION AND TURNOVER

.1 System demonstration and turnover to the Departmental Representative shall occur when:
.1 The installation is complete;
.2 Acceptance test conducted by the Consultant has been successfully completed;
.3 Commissioning Agent system testing has been successfully complete;
.4 Training and instruction has been completed;
.5 Operating and Maintenance Manual have been accepted;
.6 Shop drawings have been updated;
.7 As-built drawings have been completed.

.2 Systems demonstration shall be conducted by Contractor and manufacturers. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.

1.22 TESTING FORMS

.1 Contractor and manufacturers shall provide information required to complete forms listed in this Section and any other additional data sheets not included in this specification, but required for the mechanical and electrical systems of this Project. All forms to be provided by the Contractor and shall be approved by the Consultant and the Commissioning Agent.

.2 Commissioning index form shall be maintained by Commissioning Agent to track progress of the commissioning requirements.

.3 Mechanical testing and verification forms to be completed are as follows wherever applicable, but not limited to:

- .1 Commissioning index form;
- .2 Drainage testing form;
- .3 Equipment test form;
- .4 Piping pressure test form;
- .5 System and equipment warranty dates form;
- .6 System verification form;
- .7 Test identification form;
- .8 Testing and start-up schedule form;
- .9 Air handling unit data sheet;
- .10 Chemical treatment data sheet;
- .11 Coil data sheet;
- .12 Controller device data sheet;
- .13 Controls data sheet;
- .14 Damper data sheet;
- .15 Fan data sheet;
- .16 Filter data sheet;
- .17 Boiler data sheet;
- .18 Chiller data sheet;
- .19 Computer Room A/C unit data sheet;
- .20 Heat exchanger data sheet;
- .21 Humidifier data sheet;
- .22 Pressure reducing valve data sheet;
- .23 Pump data sheet;
- .24 Wall fin radiation data sheet;
- .25 Self-contained air conditioning unit data sheet;
- .26 Heater data sheet
- .27 Chilled beam data sheet.
- .28 VAV Box data sheet

1.23 EQUIPMENT AND SYSTEM WARRANTIES

.1 Equipment and system warranties shall be as defined in Division1.

.2 Contractor shall fill-out the warranty form listing the equipment and systems and the start and finishing dates for warranty.

.3 Refer to Division 1, Division 15 and Division 16 of the specification for the requirements during the warranty period.

.4 Contractor shall re-visit the building during the warranty period with Consultant, Commissioning Agent and Departmental Representative. During these visits the performance of the system shall be reviewed. These visits shall occur:

  .1 Once during the first month of building operation;
  .2 Once during the third month of building operation;
  .3 Once between fourth and tenth month in a session opposite to the first and third month visits.

.5 The Departmental Representative shall organize these visits.

.6 At these meetings Departmental Representative, Consultant and Commissioning Agent shall review the performance of the systems. If the performance is satisfactory then no further action need to be taken. If unsatisfactory then Contractor will be instructed to correct deficiencies, at his cost, to the satisfaction of Consultant.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ANSI B31.1- 2001, (SI), Power Piping, (SI Edition).

.2 Manufacturers Standardization Society
- .1 ANSI/MSS-SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture.
- .2 ANSI/MSS-SP-69: Pipe Hangers and Supports - Selection and Application.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Indicate on manufacturers catalogue literature the following:
- .1 Upper attachment.
- .2 Middle attachment.
- .3 Pipe attachment.
- .4 Riser clamps.
- .5 Shields and saddles.
- .6 Sway braces.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.

.2 Support from top of structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

2.2 UPPER ATTACHMENT

.1 Concrete:
- .1 Anchor: Threaded carbon steel drop-in anchor with dull zinc finish for corrosion protection, ULC Listed.
  - .1 Acceptable Manufacturer:
    - .1 Hilti HDI-L
  - .2 Flexible Clevis Plate: Carbon steel plate with clevis, with forged steel weldless eye nut for surface mount:
    - .1 Acceptable Manufacturer:
      - .1 Anvil Plate Fig. 49, Eye Nut Fig. 290

.2 Myatt
.3 Tolco Plate Fig. 34, Eye Nut Fig. 330

.2 Steel beam/joist (bottom flange):
.1 Cold piping NPS 2 and under: malleable iron C-clamp to MSS-SP58, type 19. ULC listed.
.1 Acceptable Manufacturer:
.1 Anvil Fig. 93
.2 Myatt
.3 Tolco Fig. 66
.2 Cold piping NPS 2-1/2 and larger and all hot piping: malleable iron beam clamp with extension piece to MSS-SP58, type 28 or 29. ULC listed.
.1 Acceptable Manufacturer:
.1 Anvil Fig. 218/157
.2 Myatt
.3 Tolco Fig. 329/333

.3 Steel beam/joist (top):
.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp to MSS-SP58, type 19, ULC listed.
.1 Acceptable Manufacturer:
.1 Anvil Fig. 93
.2 Myatt
.3 Tolco Fig. 66
.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58, type 25. ULC listed.
.1 Acceptable Manufacturer:
.1 Anvil Fig. 227
.2 Myatt
.3 Tolco Fig. 60

2.3 MIDDLE AND ELECTRO-GALVANIZED ATTACHMENT (ROD)

.1 Carbon steel threaded rod black finish for mechanical rooms.
.1 Acceptable Manufacturer:
.1 Anvil Fig. 146
.2 Myatt
.3 Tolco Fig. 100

2.4 STATIONARY PIPE ATTACHMENT

.1 Adjustable Clevis Hanger:
.1 Carbon steel for cold piping, steel or cast iron:
.1 Hot piping, steel with less than 25 mm horizontal movement, hot piping, steel, with more than 300 mm middle attachment rod length. ULC listed.
.1 Acceptable Manufacturer:
.1 Anvil Fig. 260
.2 Myatt
.3 Tolco Fig. 1

.2 Cold copper piping; hot copper piping with less than 25 mm horizontal movement; hot copper piping with more than 300 mm middle attachment (rod) length: adjustable clevis to MSS-SP58, type 1. Copper plated.
  .1 Acceptable Manufacturer:
    .1 Anvil Fig. CT65
    .2 Myatt
    .3 Tolco Fig. 81
.3 Cold plastic piping middle attachment (rod) length: adjustable clevis to MSS-SP58, type 1. Copper plated.
  .1 Acceptable Manufacturer:
    .1 Anvil
    .2 Myatt
    .3 Tolco

2.5 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS-SP58, type 42. ULC listed.
  .1 Acceptable Manufacturer:
    .1 Anvil Fig. 261
    .2 Myatt
    .3 Tolco Fig. 6

.2 Copper pipe: carbon steel copper finished to MSS-SP58, type 42.
  .1 Acceptable Manufacturer:
    .1 Anvil Fig. CT121
    .2 Myatt
    .3 Tolco Fig. 82

2.6 SADDLES AND SHIELDS

.1 Cold piping NPS 2-1/4 and over: protection shield with high density insulation under shield with uninterrupted vapour barrier.
  .1 Acceptable Manufacturer:
    .1 Anvil Fig. 167
    .2 Myatt
    .3 Tolco Fig. 220
  .2 Hot piping NPS 1-1/4 and over: protective saddle with insulation under saddle.
    .1 Acceptable Manufacturer:
      .1 Anvil Fig. 160 to 165
      .2 Myatt
      .3 Tolco Fig. 260-1 to 265-4

Part 3 Execution

3.1 HANGER SPACING

.1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
  .1 Plumbing piping: most stringent requirements of National Plumbing Code of Canada, Provincial Code, or authority having jurisdiction.
  .2 Fire protection: to applicable fire code.
  .3 Copper piping: up to NPS 1/2: every 1.5m.

.4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.5 Within 300 mm of each horizontal elbow.

Maximum Pipe Size: NPS	Maximum Spacing: Rod Diameter	Maximum Spacing: Steel	Spacing: Copper	Plastic
Up to 1-1/4	10 mm	2.1 m	1.8 m	1.5 m
1-1/2	10 mm	2.7 m	2.4 m	1.6 m
2	10 mm	3.0 m	2.7 m	1.6 m
2-1/2	12 mm	3.6 m	3.0 m	1.8 m
3	12 mm	3.6 m	3.0 m	1.9 m
3-1/2	12 mm	3.9 m	3.3 m	2.0 m
4	16 mm	4.2 m	3.6 m	2.0 m
6	22 mm	5.1 m		2.3 m
8	22 mm	5.7 m		

.2 Use larger diameter rod where recommended by the hanger manufacturer.

3.2 HANGER INSTALLATION

.1 Offset hanger so that rod is vertical in operating position.

.2 Adjust hangers to equalize load.

3.3 UNDERGROUND PIPE SUPPORTS

.1 Where indicated on plan provide cast-in-place stainless steel threaded rod and pipe support (top and bottom clamp type) for storm and sanitary waste piping located below ground floor level structural slab.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Provide separate shop drawings for each isolated system. Shop drawings to include location and type of all vibration isolators. A complete tabulation showing for each vibration isolator, the design load and the minimum static deflection under design loads and approved equipment total load.

1.2 GENERAL

.1 Provide vibration isolators under all moving and rotating equipment. Maximum transmissibility: 2% maximum.

.2 Provide following services for correction of excessive vibration.
  .1 Adjust and set springs that are not operating properly.
  .2 Replace springs required to reduce the vibration levels to within design limits.

.3 Vibration isolators shall be of the type and having static deflection as noted on the drawings. The springs selected shall have the required static deflection when 2/3 solid.

.4 All vibration isolators supporting one particular piece of equipment shall be selected for equal deflections. All nuts and bolts and washers shall be zinc electroplated. Vibration isolation equipment for outdoor applications shall be neoprene coated or cadmium plated.

.5 All vibration isolators and equipment bases shall be by one manufacturer.

1.3 QUALITY ASSURANCE

.1 Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

.2 Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

.3 Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.

.4 Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

.5 Should any rotating equipment cause excessive noise or vibration, the contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

.6 Upon completion of the work, the Departmental Representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Departmental Representative that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.4 SPEED & BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

.1 Fans and other rotating mechanical equipment must not operate at speeds in excess of 80% of their first true critical speed.

.2 Vertical vibration of rotating equipment shall not be requirements for greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS peak-to-peak)
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1

Part 2 Products

2.1 SPRING SOLATORS

.1 Type SL Spring Isolators
  .1 Free standing and laterally stable without any housing. All mounts shall have levelling bolts. Spring diameter shall not be less than 0.8 compressed height of the spring at rated load. Each isolator shall be mounted on a double layer of 8mm thick ribbed or waffle neoprene separated by a 16 ga. stainless steel plate. A square bearing plate shall be provided to load the pad uniformly in the range of 275 to 340 kPa.
  .2 Acceptable Manufacturer:
    .1 Vibro-Acoustics type FS
    .2 Vibron Type VO

.2 Type SLR Spring Isolators
  .1 Open, stable pair of steel springs and include vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as a blocking during erection of equipment. Unit isolator base plate shall be c/w two layers of 8mm thick ribbed or waffle pattern neoprene pads separated by a 16 ga. stainless steel plate. Base plate shall be sized to load the pad uniformly in the range of 275 to 340 kPa.
  .2 Acceptable Manufacturer:
    .1 Vibro-Acoustics type CM
    .2 Vibron Type VOR

2.2 TYPE NSN PADS

.1 Double layer of 50mm thick durometer neoprene separated by 6.25mm steel plate.

.2 Acceptable Manufacturer:
 .1 Vibro-Accoustics type NSN
 .2 Vibron type VSV

2.3 SPRING HANGERS

.1 Type SH Spring Hangers
 .1 Vibration hangers shall contain a steel spring set in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. Spring diameters and hanger box lower hole sizes shall be large enough to permit the rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
 .2 Acceptable Manufacturer:
  .1 Vibro-Acoustics type SH
  .2 Vibron type VH

.2 Type SHR Spring Hangers
 .1 Type SHR spring hangers shall contain a laterally stable steel spring and 8mm deflection neoprene element in series. A neoprene neck shall be provided where the rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameter and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short circuiting the spring.
 .2 Acceptable Manufacturer:
  .1 Vibro-Acoustics type SHR
  .2 Vibron type VHN

2.4 EQUIPMENT BASES

.1 Type S Steel Base
 .1 Where called for on the drawings, equipment shall be mounted on type S primed steel base. Frames shall consist of structural steel sections, sized, spaced & connected to form a rigid base which will not twist, rack, deform or deflect in any manner that will negatively effect the operation of the supported equipment or performance of the vibration isolation mounts. Frames shall include side mounting brackets for attachment to Unit SL or SLR spring isolator. The clearance between the underside of the steel base and top of the building shall be at least 50mm.
 .2 Acceptable Manufacturer:
  .1 Vibro-Acoustics type S
  .2 Vibron type IS

.2 Type C Concrete Inertia Base
 .1 Formed from stone aggregate concrete cast between appropriate steel reinforced perimeter structural steel channels, complete with steel reinforced concrete. Inertia block thickness shall not be less than 1/12th the longest dimension of the mounted equipment. Provide side clearance between underside of the inertia base and top of building structure under operating conditions.

.2 Acceptable Manufacturer:
  .1 Vibro-Acoustics Type C
  .2 Vibron CI
  .3 Concrete by this Contractor

2.5 RESILIENT LATERAL GUIDES

.1 These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

.2 Acceptable Manufacturer:
  .1 Mason Industries type ADA
  .2 Flexonics type

2.6 LEXIBLE DUCT CONNECTIONS

.1 These are specified in the ventilation sections.

2.7 FLEXIBLE PIPE CONNECTIONS

.1 Flexible pipe connections shall be fabricated of multiple plys of nylon cord, fabric and neoprene, vulcanized so as to become inseparable and homogenous. Straight connections shall be formed in a double sphere shape. Elbow connections shall have a single sphere shape at the curve of the unit. Flexible connections shall be able to accept compressive, elongative, transverse, and angular movements.

.2 The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure and fluid type. No rods or cables shall be used to control extension of the connector.

.3 Connectors for pipe sizes NPS 2 and smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

.4 Acceptable Manufacturer:
  .1 Mason type MFTNC
  .2 Flexonics Style 102

Part 3 Execution

3.1 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturers' instructions and adjust mountings to level equipment.

.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping and ducting passage through walls and floors do not transmit vibrations.

.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS 4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and over: first 6 points of support.

.2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50mm.

.4 Where isolation is bolted to floor avoid short circuiting of sound pads by using vibration isolation rubber washers.

.5 Block and shim level all bases so that ductwork and piping connections can be made to a right system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

.6 Provide coating for outdoor use even for indoor isolators.

3.2 SITE VISIT

.1 Arrange for manufacturer's representative to visit site to ensure installation is in accordance with manufacturer's instructions and make adjustments and corrections in accordance with written report.

.2 Provide Departmental Representative with notice 48h in advance of manufacturer's representative's visit.

3.3 TESTING

.1 Experienced and competent sound and vibration testing professional Departmental Representative to take vibration measurement for HVAC systems after start-up and final corrections and balancing of systems. If sound and vibration issues are present and contractor is required by Departmental Representative, costs to be borne by Mechanical Contractor.

.2 Vibration measurements shall be taken for isolated equipment listed in schedules on drawings.

.3 Provide Departmental Representative with notice 24 h in advance of commencement of tests.

.4 Submit complete report of test results including sound curves. Report should establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations.

3.4 FLEXIBLE CONNECTIONS

.1 Provide flexible pipe connections at all piping connections to all the vibrating and rotating equipment, including pumps, chillers, compressors and condensing units, etc.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CGSB 1-GP-60M-78, Enamel, Interior, Gloss, Alkyd Type.

.2 CGSB 24-GP-3a-67, Identification and Classification of Piping Systems.

1.2 SAMPLES

.1 Submit samples in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Submit samples and lists of proposed wording for approval before engraving.

Part 2 Products

2.1 MANUFACTURERS NAMEPLATES

.1 Provide metal nameplate on each piece of equipment, mechanically fastened complete with raised or recessed letters.

.2 Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

2.2 SYSTEM NAMEPLATES

.1 Colour:
- .1 Hazardous: red letters, white background.
- .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:
- .1 3 mm thick, laminated plastic or white anodized aluminum, matte finish, square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:
- .1 Conform to following table:

Size No.	Dimensions (mm X mm)	No. of Letter Lines	Height (mm)
1	10X 50	1	3
2	13 X 75	1	5
3	13 X 75	2	3
4	20 X 100	1	8
5	20 X 200	1	8
6	20 X 200	2	5
7	25 X 125	1	12
8	25 X 125	2	8
9	35 X 200	1	20

.2 Use average of 25 letters/numbers (maximum) per nameplate.
.3 Use size #6 for terminal cabinets and control panels.

.4 Facilities Inspection Program (FIP) identification:
.1 General: use system of Main Identifier, Source Identifier, and Destination Identifier.
.2 Equipment and Mechanical Rooms: Main Identifier: size #9; Source and Destination Identifiers: size #5.
.3 Elsewhere: Sizes as appropriate.

2.3 PIPING

.1 General:
.1 To CGSB 24-GP-3a.
.2 Identify medium by lettered legend, classification by primary and secondary colours, direction of flow by arrows.

.2 Sizes:
.1 Legend: block capitals to following table:

Outside Dia. of Pipe or Insulation mm	Size of Letters mm
30	13
50	19
150	32
250	63
Over 250	88

.3 Primary colour bands:
.1 At valves and fittings: 500 mm long.
.2 Elsewhere: 1000 mm long.
.3 Secondary colour bands: 50 mm wide, 75 mm in from one end of primary colour band.

.4 Arrows:
.1 Outside diameter of pipe/insulation 75 mm and greater: 150 mm long x 50 mm high.
.2 Outside diameter of pipe/insulation less than 75 mm: 100 mm long x 50 mm high.
.3 Use double headed arrows where flow is reversible.

.5 Material:
.1 Paint: to CGSB 1-GP-60M.
.2 Legend markers, arrow colour bands: plastic coated cloth material with protective overcoating and waterproof contact adhesive undercoating, suitable for 100% RH and continuous operating temperature of 150°C and intermittent temperature of 200°C. Apply to prepared surfaces. Wrap tape around pipe or pipe covering with ends overlapping one (1) pipe diameter.
.3 Waterproof and heat resistant plastic marker tags: for pipes and tubing 20 mm nominal and smaller.

.4 Acceptable Manufacturer:
.1 Brade
.2 Seton

.6 Colours:
.1 Submit legend, primary and secondary classification colours to Departmental Representative for approval, prior to commencing any mechanical identification.
.2 Pipe and Valve Identification Table:

Contents	Valve Legend	Pipe Legend	Background Colour Marking
Chilled Water Supply	C.W.S.	Ch Wtr. Supply	Green
Chilled Water Return	C.W.R.	Ch. Wtr. Return	Green
Hot Water Heating Supply	H.W.S. (R)	Heating Supply	Yellow
Hot Water Heating Return	H.W.R. (R)	Heating Return	Yellow
Glycol Heating Supply	H.W.S. (HC)	Glycol Heating Supply	Yellow
Glycol Heating Return	H.W.S. (HC)	Glycol Heating Return	Yellow
Glycol Heat Recovery Supply	G.L.S. (HR)	Glycol H.R. Supply	Yellow
Glycol Heat Recovery Return	G.L.R. (HR)	Glycol H.R. Return	Yellow
Humidifier Steam Supply	Hum. LPS	Hum. LPS	Yellow
Domestic Hot Water Supply	D.H.W.	DHW	Green
Domestic HWS Recirculation	DHW (R)	DHWR	Green
Domestic Cold Water Supply	DCW	DCW	Green
Storm Water	ST.S	Storm	Green
Sanitary	SAN	SAN	Green
Lab Waste	Lab SAN	Lab Waste	Green
Lab Waste (Radiostope)	Lab (Radiostope)	Radiostope Waste	Green
Plumbing Vent	Plbg. Vent	San. Vent	Green
Clean Lab Water (RO)	CLW	Clean Lab	Yellow
Compressed Air	CA – KPA	Com. Air	Green
Fire Protection Water	F.P.	Fire Prot. Wtr.	Red
Sprinklers	F.P.	Sprinklers	Red
Instrument Air	C.A.	Instrument Air	Green
Control Air Tubing	To Section 15944	To Section 15944	
Conduit for low voltage Control Wiring	To Section 15944		

.3 Legend and arrows:
.1 Black or white to contrast with primary colour.
.2 Fire protection: white on red background.

.7 Fire protection system:
.1 Concealed piping (except sprinkler branches) in offices: identify only.
.2 Exposed piping: paint complete system and identify.

.8 Low voltage control wiring installed by Division 25.

2.5 DUCTWORK

.1 50mm high black stencilled letters and directional flow arrows 150mm long x 50mm high.

.2 Table: Ductwork Identification

Contents	**Label**	**Colour**
Supply Air Duct	S.A. – AHU-1	Black
Return Air Duct	R.A. – RF-1	Black
General Exhaust	G.E. – EF-1	Black
Sanitary Exhaust	S.E. – EF-2	Black
Lab Exhaust	Lab Exh. – EF-1	Black
Radioisotope Exhaust	Radioisotope (To RS2) + Radiation Symbol	Red

2.6 VALVES AND CONTROLLERS

.1 Laminated plastic tags with 19 mm engraved lettering. Secure with non-ferrous chains to valve bodies or stem. Use for all valves and operating controllers, including Air Valves.

.2 Furnish Departmental Representative with six identification flow diagrams of approved size for each system. Include valve tag schedule, designating number, service, function and location of each tagged item and normal operating position of valves.

2.7 CONTROLS IDENTIFICATION

.1 Identify all systems, equipment, components, controls and sensors.

.2 Inscription to identify function and, (where applicable) fail-safe position.

Part 3 Execution

3.1 GENERAL

.1 Do identification work in accordance with CGSB 24-GP-3a except where specified otherwise.

.2 Provide ULC and CSA registration plates, as required by respective agency.

3.2 LOCATION OF NAMEPLATES

.1 In conspicuous location to facilitate easy reading from operating floor and to properly identify equipment and/or system.

.2 Provide stand-offs for nameplates on hot surfaces and insulated surfaces.

.3 Do not insulate or paint over plates.

3.3 PIPING

.1 Locations:
 .1 On long straight runs in open areas in mechanical rooms, equipment rooms, galleries, and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking aisles and not at more than 17 m intervals.
 .2 Adjacent to all changes in direction.
 .3 At least once in each small room through which piping passes.
 .4 On both sides of visual obstruction or where run is difficult to follow.
 .5 On both sides of any separation such as walls, floors and partitions.
 .6 Where piping is concealed in pipe chase, ceiling space, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
 .7 At beginning and end points of each run and at each piece of equipment in run.
 .8 At point immediately upstream of major manually operated or automatically controlled valves. Where this is not possible, place identification as close to valve as possible, preferably on upstream side.
 .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
 .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

3.4 DUCTWORK

.1 Stencil over final finish only.

.2 Locations of ductwork identification:
 .1 On long straight runs in open areas in mechanical rooms, equipment rooms, galleries, and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking isles and not at more than 17 m intervals.
 .2 Adjacent to all changes in direction.
 .3 At least once in each small room through which ductwork passes.
 .4 On both sides of visual obstruction or where run is difficult to follow.
 .5 On both sides of any separation such as walls, floors and partitions.
 .6 Where ductwork is concealed in duct chase, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
 .7 At beginning and end points of each run and at each piece of equipment in run.
 .8 At point immediately upstream of major manually operated or automatically controlled dampers. Where this is not possible, place identification as close to damper as possible, preferably on upstream side.
 .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
 .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.
 .11 Beside each access door.
 .12 At 3m intervals on Radioisotope Exhaust.

3.5 VALVES AND CONTROLLER

.1 Secure tags with non-ferrous chains or closed "S" hooks for valves and operating controllers except at plumbing fixtures and radiation, except at plain sight of equipment they serve.

.2 Install one copy of flow diagram and valve schedule mounted in frame with non-glare glass in each mechanical room where directed by Departmental Representative. Provide one copy in each operating and maintenance instruction manual.

.3 Consecutively number valves in each system. Coordinate with Commissioning Agent.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 TAB: means to test, adjust and balance all systems to perform in accordance with Contract Documents.

.2 Follow start-up procedures as recommended by manufacturer unless otherwise specified.

.3 Special start-up procedures may be specified elsewhere.

.4 TAB shall be carried out by an independent agency. Agency doing TAB shall be a member in good standing of AABC or NEBB.

.5 Notify Consultant 7 days prior to start of TAB.

.6 Operate all systems to permit TAB to be performed.

.7 TAB to apply to systems, equipment and related controls specified in Division 15.

.8 Reference organization standards:
- .1 Do TAB over entire operating range in accordance with most stringent conditions of this specification and standard of following organization.
  - .1 AABC (Associated Air Balance Council).
  - .2 NEBB (National Environmental Balancing Bureau).
  - .3 SMACNA (Sheet Metal & Air Conditioning Contractors National Association).
  - .4 ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Consultants).
  - .5 PWGSC MD15126, Minimum Guidelines for Laboratory HVAC and Exhaust Systems.
  - .6 PWGSC MD128 (2013) Laboratory Fume Hoods.

.9 Start TAB only when building is essentially completed, including:
- .1 Installation of ceilings, doors, windows and other construction affecting TAB.
- .2 Application of sealing, caulking and weather stripping.
- .3 Start-up, verification for proper, safe and normal operation of mechanical and associated electrical and control systems affecting TAB including, but not limited to, the following:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air Systems:
    - Filters in place and in clean condition.
    - Duct systems clean of debris.
    - Correct fan rotation.
    - Fire and volume dampers in place and open.
    - Coil fins cleaned and combed.
    - Access doors closed and duct end caps in place.
    - All outlets installed and connected.

.4 Liquid Systems:
.1 Flushed, filled and vented.
.2 Correct pump rotation.
.3 Proper strainer baskets clean and in place.
.4 Service and balance valves open.
.5 Liquid treatment system operable.

.10 Accuracy tolerances:
.1 Do TAB to plus 10% or minus 10% of design values.
.2 Measurements to be accurate to within plus or minus 2% of actual values.

.11 Instrument calibration: to be in accordance with TAB referenced organization standard, but within 3 months of commencement of TAB.
.1 Provide proof of calibration to Consultant.

.12 Report:
.1 Format to be in accordance with TAB referenced organization standard, but using units shown in contract documents.
.2 Report to include as built full system schematics showing results of TAB.
.3 Submit 6 copies of TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of Consultant.

.13 Verification:
.1 Reported measurements shall be subject to verification by Consultant. Provide instrumentation and manpower to verify results of up to 30% of all reported measurements. Number & location of verified measurements to be at discretion of Consultant.
.2 Bear costs to repeat TAB, as required, to satisfaction of Consultant.

.14 Settings: lock and permanently mark settings as required by reference standard.

.15 Completion: TAB to be considered complete only when final reports are approved by Consultant.

.16 Fundamental and best practice building commissioning are requirements of this project in order to meet LEED requirements. Refer to Section 23 05 04 – Facility Commissioning – Mechanical.

.17 Provide a balancing plan.

.18 Provide inspection of the installation prior to start of TAB.

.19 Attend Commissioning meetings.

.20 Coordinate work with the Commissioning Authority.

.21 Reports to be provided within two (2) weeks of a system balancing.

.22 TAB Contractor to provide operating terminal to allow the setup and balance of the water and air systems.

1.2 AIR MOVING SYSTEMS

.1 General: measurements as required by referenced organization standards, including, but not limited to, following:
- .1 Measurements:
  - .1 Air velocity.
  - .2 Static pressure.
  - .3 Velocity pressure.
  - .4 Temperature:
    - .1 Wet bulb
    - .2 Dry Bulb
  - .5 Cross sectional area.
  - .6 RPM.
  - .7 Electrical power:
    - .1 Voltage
    - .2 Current draw.

.2 Location of equipment measurements:
- .1 Inlet and outlet of each:
  - .1 Fan.
  - .2 Coil.
  - .3 Filter.
  - .4 Damper.
  - .5 Other auxiliary equipment.

.3 Location of system measurements at:
- .1 Main ducts.
- .2 Main branch ducts.
- .3 Sub-branch ducts.
- .4 Each supply, exhaust and return air inlet and outlet.
- .5 Other auxiliary equipment.
- .6 All areas served by system.

1.3 HYDRONIC SYSTEMS

.1 General: measurements as required by referenced standards, including, but not limited to, following:
- .1 Measurements:
  - .1 Flow
  - .2 Pressure.
  - .3 Temperature.
  - .4 Specific gravity.
  - .5 RPM.
  - .6 Electrical Power:
    - .1 Voltage.
    - .2 Current draw.

.2 Location of equipment measurements:
  .1 Inlet and outlet of each:
    .1 Coil.
    .2 Pump.
    .3 PRV.
    .4 Make-Up (water).
    .5 Other auxiliary equipment.

.3 Location of system measurements at:
  .1 Supply and return each primary and secondary loop of following hydronic systems:
    .1 Heating water.
    .2 DHW recirculation lines.

.4 Laboratory supply and exhaust systems:
  .1 Air Balancing and verification to meet PWGSC MD15128 and Section 23 05 93.13.

.5 Perform fume hood face velocity testing in pressure of commissioning agent and Departmental Representative. Control technician to be present to assist with FH testing.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section23 05 93.13.

.2 Section 23 38 16.13

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

- .1 ANSI/ASHRAE 110-1995, Method of Testing Performance of Laboratory Fume Hoods.
- .2 ANSI/AIHA Z9.5-2003, Laboratory Ventilation.

.2 Public Works and Government Services Canada (PWGSC)

- .1 PWGSC MD15128 2008, Laboratory Fume Hoods.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Contract Conditions and Section 01 33 00 – Submittal Procedures.

1.4 CLOSEOUT SUBMITTALS

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

.2 Record Documentation:

- .1 Submit list of materials used in fume hood work.

1.5 QUALITY ASSURANCE

.1 Test Agency: fume hood tests to be performed by qualified independent testing agency with proven experience in Work of this Section and in accordance with PWGSC MD15128.

.2 Test Agency Qualification: submit proof of qualifications to Departmental Representative to demonstrate:

- .1 Minimum 3 years experience in testing of fume hoods.

Part 2 Products

2.1 TESTING EQUIPMENT

.1 Test equipment to ANSI/AIHA Z9.5 and PWGSC MD 15128.

.2 Data logger:

- .1 Speed: 10 Hz or better.
- .2 Memory: sufficient to allow data collection for duration of test.

.3 In-duct flow sensor to measure flow response:
  .1 Speed: 10 Hz.
  .2 Range: 95 L/s to 950 L/s.
  .3 Accuracy: 5%.

.4 Thermal anemometer:
  .1 .1 Mounting: on stand with probe fixed at each traverse grid location.
  .2 .2 Include: averaging function over twenty second period for each location or output recorded for 20 seconds minimum at a rate of one reading/second on data logger.
  .3 Accuracy:
    .1 .1 Below 0.50 m/s: 0.025 m/s.
    .2 .2 0.50 m/s and over: 5%.

.5 Detector for tracer gas containment:
  .1 Type: continuous reading.
  .2 Minimum Detectable Level (MDL): 0.01 ppm.
  .3 Accuracy: concentrations below 0.1 ppm: 25%; concentrations above 0.1 ppm: 10%.

.6 Smoke generator:
  .1 Use smoke generator and diffuser complying with PWGSC MD15128.

Part 3 Execution

3.1 AS INSTALLED (AI) AND INTEGRATED SYSTEMS TESTS

.1 Perform AI and integrated systems tests as follows:

  .1 After entire laboratory HVAC and exhaust systems have been tested and balanced (TAB), and TAB and Performance Verification (PV) reports have been submitted and accepted.
  HVAC and exhaust systems are in full operation.
  .2 Room temperatures are maintained between 22 degrees C and 24.5 degrees C., recorded and submitted with fume hood test documentation.
  .3 At specified laboratory space pressurization.
  Under deviation of space pressurization due to laboratory door opening and closing, change of laboratory operating modes, upset conditions, and other causes of change in laboratory air pressure.
  .4 As part of commissioning of integrated HVAC and exhaust systems and laboratory space pressurization tests included in commissioning process.

.2 After installation, test each fume hood to PWGSC MD15128 at design sash position to ensure compliance with design criteria in PWGSC MD15128.

3.2 "AI" TESTS FOR CAV BYPASS AND VAV FUME HOODS

.1 Cross draft tests:

  .1 Test air currents external to fume hood to PWGSC MD15128.
  .2 Ensure velocity of cross draft does not exceed 50% of average face velocity.

.3 Record measurements as follows:
  .1 Using thermal anemometer take readings 1.5 m above floor, 500 mm from sash, at centre, and left and right posts of fume hood.
  .2 Take readings at 1 reading/second, recorded to obtain average, and maximum and minimum values over a duration of 20 seconds at each location.
  .3 Ensure that project authority reduces excessive values to less than 50% of average face velocity before proceeding with further fume hood testing.

.2 Visualization (smoke) tests:

  .1 Extent of tests and performance criteria: to PWGSC MD15128.

.3 Face velocity and flow response test pass ratings: to PWGSC MD15128.

  .1 Average face velocity for CAV bypass fume hoods: 0.5 m/s
  .2 CAV bypass effectiveness at 150 mm sash opening; 1.25 m/s maximum average face velocity.
  .3 Average face velocity for high performance fume hoods: 0.35 m/s, with no reading less than 0.25 m/s.
  .4 VAV face velocity and flow response tests:
    .1 Average face velocity at design sash position: 0.5 m/s
    .2 Average face velocity with sash at 66% of design sash position: 0.5 m/s 0.025 m/s
      .1 Variation allowed for individual readings: 20%
    .3 Average face velocity with sash at 33% of design sash position: 0.5 m/s 0.025 m/s.
      .1 Variation allowed for individual readings: 20%
    .4 Response time: time to reach 90% of the average steady state value: within 3 seconds of initial sash movement
    .5 Test for VAV minimum flow with sash closed: to ANSI/AIHA Z9.5 capable of maintaining 375 air changes per hour.

.4 Tracer Gas tests:

  .1 Performance criteria: to PWGSC MD15128.
  .2 Conduct tests at target average face velocity.
  .3 Use approved tracer gas.
  .4 Perform tests with probe at height of 560 mm above work surface.
  .5 Leakage with sash at normal operating position:
    .1 Average leakage: 0.05 ppm maximum.
    .2 Peak reading: 0.25 ppm.
  .6 Leakage with sash in fully open position:
    .1 Average leakage: 0.05 ppm maximum.
    .2 Peak reading: 0.25 ppm.
  .7 Peripheral scan:
    .1 Record significant peak readings and their locations.
    .2 Record 30 second rolling averages.
    .3 Maximum 0.25 ppm for any 30 second rolling average.
    .4 Include readings in test report.

.8 Sash Movement Effect (SME), to determine potential for escape after movement of sash to ANSI/ASHRAE 110 procedures:

.1 Maximum 45 second rolling average: 0.05 ppm.

.5 Conduct VAV Response Tests, Stability Tests and SME simultaneously for VAV fume hoods.

3.3 AS USED (AU) TESTS WITH LAB APPARATUS IN PLACE

.1 Repeat smoke tests, velocity tests, and tracer gas tests only if specifically noted in documents.

3.4 FUME HOOD MONITOR AND ALARM TESTS

.1 Fume Hood Monitor:

.1 Provide 3 point calibration.

.2 Ensure each monitor initiates alarms (audible, visual, and BMS) when unsafe velocity conditions occur.

.3 Ensure monitor readings are displayed in metres per second, to 2 decimal places.

.2 Fume Hood Monitor/Alarm testing:

.1 Monitor accuracy test: ensure monitor is accurate within 5% of average face velocity.

.2 Alarm enunciation test: ensure alarm occurs beyond 20% of design flow set point.

.3 Alarm response enunciation test: ensure alarm delay is 10 seconds maximum.

3.5 FUME HOOD STATIC PRESSURE TEST

.1 With sash at design position and face velocity at target setting, fume hood static pressure: less than 62 Pa.

3.6 NOISE LEVEL TEST

.1 With sash at design position and face velocity at target setting, noise level at working position in front of fume hood: less than 70 dBA.

3.7 VERIFICATION LABELS

.1 Affix label to front of fume hood indicating verification, name of testing agency, and date.

3.8 COMMISSIONING - INTEGRATED SYSTEMS TESTS

.1 Do commissioning tests in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and 23 05 04 – Facility Commissioning - Mechanical.

.2 Fume hood testing to commence only after laboratory HVAC systems are fully commissioned, including calibration of airflow controls, calibration of automatic temperature controls, balance of air supply, completion of duct traverse on each fume hood exhaust duct, and completion of an air balance of the total exhaust flow.

.3 Test fume hoods in conjunction with complete laboratory integrated HVAC and exhaust systems commissioning testing including, room air flow patterns, temperature, humidity, pressurization, noise, and vibration.

3.9 REPORTS

.1 Ensure test reports are signed by testing agency before submitting to Departmental Representative.

3.10 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning and 23 38 00 – Cleaning of HVAC Systems.

.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 11 - Cleaning.

3.11 PROTECTION

.1 Protect adjacent materials from work associated with testing and maintenance of fume hoods.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Meet NFPA 90A-1985. Maximum flame spread rating of 25 and maximum smoke developed ratings of 50 in accordance with NFPA 255-1984 and CAN4-S102-M83 for all components of insulation system. Materials tested in accordance with ASTM C411-82.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit for approval manufacturer's catalogue literature related to installation.

1.3 DEFINITIONS

.1 For purposes of this section:
- .1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
- .2 "EXPOSED" - will mean "not concealed" as defined herein. Mechanical Rooms are considered as exposed areas.

1.4 ACCEPTABLE MANUFACTURERS

.1 Specification lists products by Fibreglass.

.2 The following Equivalent products shall be acceptable:
- .1 Manson
- .2 Knauf
- .3 Johns Manville

Part 2 Products

2.1 GENERAL

.1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.

.2 Materials to be tested in accordance with ASTM C411.

2.2 D-1 DUCT INSTALLATION WITH VAPOUR BARRIER

.1 Application: Ductwork up to 900mm for:
- .1 All fresh air intake ducts.
- .2 Exhaust air ductwork from fan or damper to exhaust louvers.
- .3 All supply air ducting from the rooftop air handling units to the chilled beams fro all areas and supply air diffusers for VAV systems.

.4 All exhaust air ductwork from rooftop air handling units and exhaust fans to 3m inside building.
.5 All supply air ducting from heat pumps units to supply air diffusers.
.6 Supply and exhaust air ductwork for the Parking Area does not require insulation.

.2 Material:
.1 CGSB 51-GP-11M+Amdt-Apr-78 mineral glass fibre blanket. CGSB-51-GP-52 for vapour barrier.
.2 Acceptable Manufacturers: Fibreglass faced flexible duct insulation with vapour barrier, Knauf Duct Wrap, Manson.

.3 Thickness:
.1 50mm for exhaust & fresh air plenums.
.2 25mm for ducting.

2.3 D-2 FIBREGLAS RIGID WITH VAPOUR BARRIER

.1 Application: Ductwork over 925mm and all exposed ductwork 900mm and below for the following:
.1 Exhaust air ducting from fan or damper to exhaust louver.
.2 All fresh air intake duct.
.3 All supply duct in Mechanical Room.
.4 Supply and exhaust air ductwork for the Parking Area does not require insulation.

.2 Material:
.1 CGSB 51-GP-10M, rigid mineral fibre board; CGSB 51-GP-52M vapour barrier, jacket and facing material.
.2 Acceptable Manufacturers: AF-530 vapour-seal duct insulation, Knauf Insulation Board, Manson.

.3 Thickness:
.1 25mm for air ducts.
.2 50mm for exhaust & fresh air plenums.

2.4 HIGH TEMPERATURE INSULATION

.1 Application: Kitchen exhaust ductwork.

.2 Material: Thermal insulating wool tested to ASTM C411 up to 538^{o}C. 3M FireMaster or approved equal.

.3 Thickness: 2 layers of 25mm thick each.

.4 Finish: Canvas jacket, for both exposed and concealed locations.

2.5 FASTENINGS

.1 Tape: self adhesive, 100mm wide, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.

.2 Contact adhesive: quick-setting, non-flammable fire resistive to adhere fibrous glass to ducts. Flame spread 15, smoke development 0.

.3 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.

.4 For Canvas:
  .1 Washable adhesive for cementing canvas lagging cloth to duct insulation.

.5 Pins.
  .1 Weld pins 4mm diameter, with 38mm diameter head for installation through the insulation. Length to suit thickness of insulation.
    .1 Acceptable Manufacturers:
      - Duro Dyne
      - Clip-Pin
  .3 Weld pins 2mm diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retain clips 32mm square.
    .1 Acceptable Manufacturers:
      - Duro Dyne spotter pins with spotter clips or stop clips as required.

.6 Provide adhesive, sealants and coatings with VOC content limits lower than stated in the State of California's South Coast Air Quality Management District (SCAQMD) Rule #1168, current edition.

2.6 JACKETS

.1 Canvas.
  .1 Apply in exposed areas: ULC listed plain weave, cotton fabric at 11 oz/ft2.
  .2 Acceptable Manufacturers:
    - S. Fattal Thermocanvas or equal.

Part 3 Execution

3.1 APPLICATION

.1 Apply insulation after required tests have been completed and approved by Consultant. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes to manufacturer's recommendations and as specified.

.2 Vapour barriers and insulation to be unbroken over full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves and supports.

.3 Use stand-offs for all duct mounted control accessories.

.4 Apply 20 ga. thick galvanized sheet metal corners to all ductwork in mechanical rooms.

3.2 INSTALLATION

.1 General:
  .1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
  .2 Adhere and seal vapour barrier using vapour seal adhesives.
  .3 Stagger longitudinal and horizontal joints, on multi-layered insulation.

.2 Mechanical fastenings:
  .1 On rectangular ducts, use 50% coverage of insulating cement and weld pins at not more than 200mm centres, but not less than 2 rows per side and bottom.

3.3 SIZING

.1 Provide fire retardant coating on canvas jackets.

.2 Fire retardant coating shall be U.L. approved.

.3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for painting.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.2 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.3 ASTM B209M-01, Specification for Aluminium and Aluminium Alloy Sheet and Plate.

.4 CAN/ULCS102-M83, Surface Burning Characteristics of Building Materials and Assemblies.

.5 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.6 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Building.

.7 CGSB 51-GP-52M-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.8 CAN/CGSB-51.53-95 Poly (Vinyl Chloride) Jacketing Sheet for Insulating Pipes, Vessels and Round Ducts.

.9 ASTM C335-95, Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulations.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

1.3 SAMPLES SUBMITTALS

.1 Submit samples in accordance with Section 01 33 00 -Shop Drawings and Other Submittal Procedures.

.2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

1.4 DEFINITIONS

.1 For purposes of this section:
  .1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.

.2 "EXPOSED" - will mean "not concealed" as defined herein.

Part 2 Products

2.1 GENERAL

.1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN/ULC-S102.

.2 Materials to be tested in accordance with ASTM C411.

2.2 P-1 FORMED MINERAL FIBRE TO 200°C

.1 Application: for piping, valves and fittings on:
- .1 Domestic hot water, temperature 60°C.
- .2 Domestic hot water recirculation, temperature 60°C.
- .3 Hot water heating.
- .4 Glycol heating.
- .5 Low pressure steam piping, temperature 120°C.
- .6 Condensate return piping, temperature 100°C.
- .7 Steam vent piping.

.2 Material:
- .1 CGSB-51-GP-9M, rigid mineral fibre sleeving for piping and CGSB-51-GP-52M, vapour jacket and facing material.
- .2 Acceptable Manufacturer:
  - .1 Fibreglas 850 Pipe insulation with ASJ jacket
  - .2 Knauf pipe insulation with ASJ jacket
  - .3 Johns Manville

.3 Insulation thickness for services not listed in the table shall be 25mm.

SERVICE	**PIPE SIZE**			
	Up to 1”	**1-1/4” to 2”**	**2-1/2” to 4”**	**6” and Larger**
Hot Water Heating	25mm	25mm	38mm	
Domestic Hot Water & Recirculation	25mm	25mm	25mm	25mm
Low Pressure Steam and Condensate	25mm	25mm	25mm	38mm

2.3 P-2 FORMED FIBRE WITH VAPOUR BARRIER TO 85°C

.1 Application: for piping, valves and fittings on:
- .1 Domestic cold water.
- .2 Chilled water piping.
- .3 Rainwater piping.
- .4 All other cold piping systems.

.2 Material:
  .1 CGSB 51-GP-9M, rigid mineral fibre sleeving for piping and CGSB 51-GP-52M, vapour barrier jacket and facing material.

.2 Acceptable Manufacturer:
  .1 Fibreglas 850 pipe insulation with ASJ jacket
  .2 Knauf pipe insulation with ASJ jacket
  .3 Johns Manville

.3 Thickness:
  .1 All piping: 25mm.
  .2 All piping provided with heat tracing: 50mm.
  .3 All rain water leader piping 25mm.

2.4 P-3 FLEXIBLE MINERAL FIBRE WITH VAPOUR BARRIER TO 850°C

.1 Application on:
  .1 Underside of roof drain body.
  .2 Material:
    .1 CGSB 51-GP-11M, mineral fibre blanket for piping and CGSB 51-GP-52M vapour barrier jacket and facing material.
  .3 Thickness: all sizes, 25 mm.

2.5 FASTENINGS

.1 For insulation systems P-1, P-2:
  .1 Tape: self adhesive, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
    .1 Acceptable Manufacturer:
      .1 Fatal Insultape
  .2 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
    .1 Acceptable Manufacturer:
      .1 Childers CP-80
  .3 Lagging adhesive: fire retardant coating.
    .1 Acceptable Manufacturer:
      .1 Childers CP-50A-HV2

.2 For insulation system P-3 and underside of roof drain body.
  .1 Contact adhesive: quick-setting for seams and joints.
  .2 Tape: self adhesive PVC.
    .1 Acceptable Manufacturer:
      .1 Childers CP-82

2.6 INSULATION CEMENT

.1 Air drying to ASTM C449/C449M.

2.7 JACKETS

.1 Canvas:
.1 Apply in Mechanical Rooms, Service Corridors, Sprinkler Rooms, and all exposed piping inside the building. ULC listed plain weave, cotton fabric at 220 g/m^2.
.2 Acceptable Manufacturer:
.1 S. Fattal Thermo Canvas, or equal.
.3 Use of PVC jacket will not be acceptable.

2.8 REMOVABLE PREFABRICATED AND ENCLOSURES

.1 Application: Expansion joints, valves, orifice plates, strainers and Prefabricated unions.

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:
.1 Flexible or performed to fit components.
.2 Thickness to match application.
.3 Chilled and Domestic Water Systems: provide vapour barrier.
.4 Enclosure: aluminum or stainless steel 1.3mm thick to match adjacent pipe insulation. Insulation pads will be acceptable on hot piping system.

Part 3 Execution

3.1 APPLICATION

.1 Apply insulation after required tests have been completed and approved by Departmental Representative. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations and as specified herein.

.2 Insulation on roof drain body held in place with 100% coverage of adhesive.

.3 On piping with insulation and vapour barrier, install high density insulation under hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.

3.2 INSTALLATION

.1 Install in accordance with TIAC National Standards and in a manner to facilitate removal for repair. Place sections or blocks so least possible damage to insulation will result from inspections or repairs to piping or equipment.

.2 Preformed: sectional up to NPS 12, sectional or curved segmented above NPS 12.

.3 Multi-layered: staggered butt joint construction.

.4 Vertical pipe over NPS 3: insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter, locate on 4.5 m centres or less.

.5 Expansion joints in insulation: terminate single layer and each layer of multiple layers in straight cut at intervals recommended by manufacturer. Leave void of 25 mm between terminations. Pack void lightly with P3 flexible mineral insulation.

.6 Seal and finish exposed ends and other terminations with insulating cement.

.7 Expansion joints in piping: provide for adequate movement of expansion joint without damage to insulation or finishes.

.8 Orifice plate mounting flanges, flanges and unions at equipment, expansion joints, valves, other components requiring regular maintenance: omit insulation and bevel away from studs and nuts to permit use of tools without damage to insulation, install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.

.9 Insulation is not required for:
  .1 Chrome plated piping, valves and fittings.

.10 Use of flexible duct insulation on pipe elbows and fittings shall not be acceptable.

3.3 FASTENINGS

.1 Secure pipe insulation by tape at each end and centre of each section, but not greater than 900mm on centres.

3.4 SIZING

.1 Provide fire retardant coating on canvas jackets.

.2 Fire retardant coating shall be U.L. approved.

.3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide a total of two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for priming.

3.5 HANGERS

.1 Hot Piping:
  .1 For pipes up to 50mm, provide proper covering shields, sized to suit the insulated pipe, between the pipe insulation and the pipe hanger or support.
  .2 Where roller hangers and supports are used for hot piping 50mm diameter and larger, steel protection saddles shall be supplied and installed as part of the piping work. Pack the saddle voids with fiberglas insulation.

.2 Cold Piping:

.1 Use calcium silicate insulation at all hanger locations on cold piping systems, except domestic water piping. Calcium silicate insulation length to be 450 mm. Thickness of insulation to be the same as specified on adjacent insulation.

3.6 DEMOUNTABLE INSULATION

.1 Insulation on valves, flanges and orifice plates for steam flow measurements and other fittings requiring access for servicing shall be demountable.

3.7 VALVES, FITTINGS AND COUPLINGS

.1 Do not apply insulation over flanged joints or couplings until and piping has been brought up to operating temperature and flange bolts have been fully tightened.

.2 Insulate flanges, valves, and special accessories with covering equal in temperature resistance and thickness to that of the connecting piping.

.3 Fittings for pipe sizes NPS 2 and smaller may be insulated with hydraulic setting insulating cement or equal, to thickness equal to adjoining pipe insulation. Apply final coat of fitting mastic over insulating cement.

.4 Insulate fittings for pipe sizes NPS 2-1/2 and larger with segments of moulded insulation securely wired in place and coated with skim coat of insulating cement. Apply fitting mastic, fitting tape and finish with final coat of fitting mastic.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

1.2 GENERAL

.1 This section is applicable to Ductwork up to 750 Kpa.

Part 2 Products

2.1 LOW PRESSURE DUCTWORK

.1 All return and general exhaust ductwork and exhaust fans to be constructed for 500 Pa. operating pressure. Ductwork designed for 500 Pa. operating pressure shall be constructed as per Table 1-5, SMACNA HVAC Duct Construction Standards.

.2 All supply ductwork for AHU-1 & 2 and fume hood exhaust ductwork to be constructed for 1000 Pa. Ductwork designed for 1000 Pa operating pressure to be constructed as per Table 1-7, SMACNA HVAC Duct Construction Standards.

2.2 GALVANIZED STEEL DUCTWORK

.1 Ducts: Lock forming quality steel with G90 designation zinc coating to ASTM A525-79. Gauge of ducts shall be in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE Guide Book.

.2 Fabrication: Ducts and fittings configuration in accordance with recommendation of SMACNA and ASHRAE.

.3 Joints: to ASHRAE. Class B seal.

.4 All low pressure Ductwork except applications listed in Item 2.5 of this section to be of galvanized steel.

2.3 ALTERNATE TRAVERSE DUCT JOINT SYSTEM

.1 Alternate transverse duct joint system shall include angles, corners, metal cleats, closed cell neoprene gaskets, corner clips and integral mastic sealant.

.2 Alternate transverse duct joint system shall be installed as per manufacturer's recommendations.

.3 When the gasket is applied around the corner of the alternate transverse duct joint system, reverse direction twice in order to apply three layers of gasket at each corner.

.4 Use bolts at the corners of "no-bolt" corner clips.

.5 Use metal drive cleats on all four sides of the joints. Cleats to be 150mm long and 450mm on centers.

.6 Acceptable Manufacturer:
- .1 Ductmate Transverse Joint System
- .2 Nexus PDQ

2.4 HANGERS AND SUPPORTS

.1 Hangers and Supports:
- .1 Fabricate strap hangers to same material as duct. Hanger configuration to SMACNA duct.
- .2 Rod and angle hangers: galvanized steel to SMACNA details with cadmium plated black iron rods to SMACNA details.
- .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel decks or use power actuated fasteners.

2.5 SPECIAL DUCT MATERIALS

.1 Stainless Steel:
- .1 Ducts type 304 stainless steel to ASTM A480-79. Gauge of ducts to be in accordance with recommendations of ASHRAE, but not less than 0.8mm.
- .2 Fabrication: ducts and fittings configuration to be in accordance with recommendations of SMACNA and ASHRAE.
- .3 Joints: to be continuous inert gas welded, liquid tight external joints.
- .4 Application: Exhaust ductwork for the fume hoods, exhaust canopies, bench level exhausts in laboratory continuous from exhaust air valve to exhaust plenum.
- .5 The ductwork shall be reinforced adequately to ensure that there are no ductwork noises on fan start-up and shut-down.

Part 3 Execution

3.1 DUCT INSTALLATION

.1 Install steel duct in accordance w/ SMACNA standards.

.2 Do not break continuity of insulation vapour barrier by hangers or rods.

.3 Ground across flexible connector with No. 2/0 braided copper strap.

.4 Install balancing dampers at all branch ducts and as indicated.

.5 Anchor all risers.

.6 Install fire dampers to NFPA 90A.

.7 Make fresh air intake ducts watertight up to end of transition. Fit drain connections on bottom with minimum 31mm pipe to nearest funnel drain.

.8 Under no circumstances will pipes or wires be permitted to penetrate ducts.

.9 Hangers shall be galvanized steel angles with supporting rods, locking nuts and washers to the following table:

DUCT SIZE	ANGLE SIZE	ROD SIZE	SPACING
Up to 750 mm	25 X 25 X 3 mm	6 mm	3 m
751 to 1050mm	37 X 37 X 3mm	6 mm	3 m
1051 to 1500mm	37 X 37 X 3 m	10mm	3 m
1501 to 1800mm	50 X 50 X 3 m	10mm	2.6 m
1801 to 2400 mm	50 X 50 X 5mm	10mm	2.6 m
2401 and Over	50 X 50 X 6mm	10mm	2.6 m

3.2 WATERTIGHT DUCT

.1 Provide watertight Ductwork for:
.1 Fresh air intake and plenums.
.2 Exhaust air plenums.
.3 Drain pans.

.2 Form bottom of duct without longitudinal seams. Solder or weld joints of bottom sheets and 150mm up sides. Solder or weld transverse joint and caulk.

.3 Fit base of risers with 150mm deep drain sump and 37mm drain connection, with deep seal trap and valved drain line to open funnel drain.

.4 Install air tight access door and cleanouts on 5m centers for horizontal ducts, at each change in direction, at each floor for vertical runs and at each side of exhaust fans. Provide access door at each turn in direction.

3.3 FRESH AIR EXHAUST OPENINGS

.1 Install to SMACNA details.

.2 Reinforce and brace air outlets and intakes for wind speed as per NBC for location.

.3 Provide air inlet openings with 1.6mm thick 25mm wire mesh screen and air outlet openings with 12mm mesh screwed aluminum birdscreens.

3.4 INSTRUMENT AND TEST HOLES

.1 Install NPS 1 test plugs with chain and cap, where required to accommodate testing and balancing instruments
.1 Acceptable Manufacturer:
.1 Duro-Dyne

3.5 DUCT LEAKAGE

.1 Ductwork shall be free of audible leaks in quiet ambient.

3.6 JOINT SEALING

.1 Seal all duct joints with an approved liquid tight sealant in accordance with SMACNA HVAC Duct Standards.

3.7 PROTECTION OF DUCT OPENINGS

.1 Seal and protect all open ends of Ductwork during construction.

.2 Where ducts are shown connecting to concrete or masonry openings and along edges of plenums at floors and walls, provide continuous 50mm x 50mm x 6mm galvanized angle iron. Bolt angle iron to structure and make airtight with caulking compound.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS

.1 Submit shop drawings and technical information in accordance with Section 01 33 00 – Shop Drawings and Other Submittal Procedures.

Part 2 Products

2.1 HIGH PRESSURE DUCTWORK

.1 Ductwork for Articulating Exhaust Arm Systems (AAE) to be designed for operating pressure of 1250 Pa negative.

2.2 STAINLESS STEEL DUCT

.1 Application:

- .1 Ductwork for Articulating Exhaust Arm System to be designed for operating pressure of 1250 Pa negative.
- .2 Material: Ducts type 304 stainless steel of lock forming quality to ASTM A480-79. Gauges of ducts to be in accordance with recommendations of ASHRAE but not less than 20 ga. thick. Duct reinforcement to be as per SMACNA HVAC Duct Construction Standards.
- .3 Fabrication: Ducts and fittings configuration to be in accordance with SMACNA and ASHRAE.
- .4 Joints: to be continuous gas welded, liquid tight external joints.
- .5 The ductwork shall be reinforced to ensure that there are no ductwork noises on fan start-up and shutdown.

2.3 HANGERS AND SUPPORTS

.1 Fabricate strap hangers to same material as ducts. Hanger configuration to SMACNA details.

.2 Rod and angle hangers: galvanized steel to SMACNA details with black iron rods to SMACNA details.

.3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel decks or use power actuated fasteners unless approved by the Structural Departmental Representative.

.4 Provide ceiling support bracket for all articulating arm locations as shown. Ceiling bracket to be white powder coated steel. Standard of Acceptance: Nederman Part No. 371626 – 1000mm long.

Part 3 Execution

3.1 DUCT INSTALLATION

.1 Install steel duct in accordance with SMACNA standards.

.2 Do not break continuity of insulation vapour barrier by hangers or rods.

.3 Ground across flexible connector with No. 2/0 braided copper strap.

.4 Install balancing dampers at all branch ducts and as indicated.

.5 Anchor all risers.

.6 Install fire dampers to NFPA.

.7 Make fresh air intake ducts watertight up to end of transition. Fit drain connections on bottom with minimum 1-1/4" pipe to nearest funnel drain.

.8 Hangers shall be galvanized steel angles with supporting rods, locking nuts and washers to the following table:

DUCT SIZE	ANGLE SIZE	ROD	SPACING
Up to 750 mm	25 X 25 X 3 mm	6 mm	3 m
751 to 1050mm	37 X 37 X 3mm	6 mm	3 m
1051 to 1500mm	37 X 37 X 3 m	10m	3 m
1501 to 1800mm	50 X 50 X 3 m	10m	2.6 m
1801 to 2400 mm	50 X 50 X 5mm	10m	2.6 m
2401 and Over	50 X 50 X 6mm	10m	2.6 m

3.2 INSTRUMENTS AND HOLES

.1 Install 25mm test plugs with chain and cap, where required to accommodate testing and balancing instruments.
  .1 Acceptable Manufacturer:
    .1 Duro-Dyne.

3.3 DUCT LEAKAGE TESTING

.1 Test a section of ductwork comprising of at least 300m² of duct surface area c/w fittings and elbows.

.2 Make first leak test to demonstrate workmanship. Ensure at least five transverse joints and typical fittings plus one 90° elbow are included. The first test is for the purpose of reviewing the general workmanship and test procedures. Leak test all fume hood exhaust ducting.

.3 Install no additional ductwork until the first test has been passed.

.4 Leak test high pressure ductwork at 1250 Pa.

.5 Ductwork shall be free of audible leaks in quiet ambient. Leakage shall not exceed 61 Pa per $30m^2$ of duct surface area.

.6 Leak testing of all the ductwork shall be carried out by an independent testing agency retained by this Section.

.7 Should the first testing on any section of ductwork prove to be unsatisfactory, additional testing shall be carried out at no cost until all testing proves to be satisfactory.

3.4 WATER TIGHT DUCT

.1 All high pressure ductwork shall be water tight.

3.5 PROTECTION OF DUCT OPENING

.1 Seal and protect all open ends of ductwork during construction.

3.6 ARTICULATING ARM BRACKET

.1 Install bracket in locations as indicated on Architectural drawings.

.2 Provide additional steel support as required to meet required ceiling height.

.3 Install as per manufacturer’s instructions.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

.1 Provide all materials, equipment, labour, services and related items required for the complete installation of noise control treatment in excellent working order as shown on the drawings or specified herein.

1.2 MATERIALS AND EQUIPMENT

.1 Noise control products specified herein shall each be supplied by a single approved manufacturer.
  - .1 Acceptable Manufacturers:
    - .1 Vibron
    - .2 Vibro Acoustics
    - .3 VAW

.2 Unless otherwise specified, supply only new equipment, parts and materials.

1.3 QUALITY ASSURANCE

.1 Supply and install any incidental equipment needed to meet all requirements even if not specified or shown on drawings without claims for additional payment.

.2 Verify correctness of equipment numbers and conformance of each component with manufacturer's specifications.

1.4 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 33 00.

.2 Prior to ordering any materials, submit the manufacturer's name, product identification, product data, and installation instructions for each product specified in this Section.

.3 Sufficient information must be provided for each product to verify compliance with all performance parameters specified hereafter.

.4 In addition to the above information, the submittal for duct silencers shall clearly indicate in a table the following information:
  - .1 The silencer identification tag.
  - .2 The specified silencer type.
  - .3 The dimensions of the silencer and its constituent parts.
  - .4 The orientation of baffles in the silencer (horizontal or vertical).
  - .5 The air flow and air velocity through the silencer.
  - .6 The pressure drop across the silencer.
  - .7 The Dynamic Insertion Loss (DIL) in octave bands with center frequencies from 63 Hz to 8000 Hz (octave bands 1 through 8).
  - .8 The sound power level of the Generated Noise (GN) in octave bands with center frequencies from 63 Hz to 8000 Hz (octave bands 1 through 8).

.5 In addition to the above information, the submittal for acoustic plenums shall clearly indicate the following:
   .1 The Transmission Loss (TL) in octave bands with center frequencies from 63 Hz (octave bands 1 through 8).
   .2 The sound absorption coefficients in octave bands with center frequencies from 63 Hz to 8000 Hz (octave bands 1 through 8).

.6 Locations, dimensions and connection details of silencers, duct liner and plenum liner shall be shown on the shop drawing submittal for ductwork.

1.5 SAMPLE

.1 Submission of samples may be required for each type of noise control product. Samples submitted will be returned after approval if requested by the contractor. All costs associated with submission of samples shall be borne by the contractor.

Part 2 Products

2.1 4" THICK ACOUSTIC PLENUMS

.1 Construct galvanized acoustic plenums using pre-fabricated 4" thick acoustic panels, and steel supports, joiner sections, floor channels, opening frames and sealing materials. Provide 16 ga. minimum channel stiffeners at not greater than 28" centers.

.2 Connect corners and butt joints with 16 ga. galvanized sections.

.3 Seal all joints with rubber mastic.

.4 Acoustic media shall be glass fiber insulation with a black surface coating to prevent fiber erosion. Semi-rigid lining shall have an average density of not less than 2 lb/cu.ft. Acoustic duct liner shall be covered with Tedlar film and 22 ga. perforated sheet metal liner.

.5 Lining shall not impart any odour to the air, delaminate or be loosened by the air stream under normal operating conditions.

.6 Entire acoustic plenums shall resist deflection and seal sufficiently to avoid air leakage when subjected to a pressure differential between inside and outside of 10 in. w.g.

.7 Doors in acoustic plenums shall have a transmission loss equal to acoustic panels.

.8 Combustion ratings shall be in accordance with ASTM E84-75, NFPA Standard 90A and UL No. 723:
   .1 Flame Spread Rating <25
   .2 Smoke Development Rating <50
   .3 Fuel Contribution Rating <50

.9 Minimum certified performance:

Octave Band	125	250	500	1000	2000	4000
Panel TL0dB)	21	28	39	50	53	56
Absorption	0.7	0.9	0.98	0.99	0.9	0.9

.10 All plenums on ductwork shall be acoustic plenums.

.11 Acceptance Manufacturer - Acoustic Plenums as made by
.1 Vibro-Acoustics
.2 Vibron
.3 VAW

2.2 DUCT SILENCERS

.1 Outer casings of silencers shall be fabricated from not less than 22-gauge galvanized steel in accordance with ASHRAE Guide or SMACNA recommended construction for high pressure ductwork. Seams shall be lock-formed and mastic filled. Interior casings for silencers shall be fabricated from not less than 26-gauge galvanized perforated steel.

.2 Silencers shall not leak air or fail structurally when subjected to a differential air pressure of 8" water gauge inside to outside of casing.

.3 Filler material shall be not less than 1 lb/cu.ft. inorganic material or glass fiber packed under at least 5% compression. Materials shall be inert, vermin and moisture proof. Combustion rating of the filler material shall not be less than the following when tested in accordance with ASTM E84-75, NFPA Standard 90A and UL No. 723:
.1 Flame Spread Rating <25
.2 Smoke Development Rating <50
.3 Fuel Contribution Rating <50

.4 Acoustical testing shall conform to ASTM E-477-96 standard method of testing duct liner material and manufactured silencers for acoustical and air flow performance. Tests shall be run both with and without air flowing through the silencer at not less than three(3) different flow rates. All ratings shall be based on test data from a recognized NVLAP accredited laboratory. Test methods shall eliminate effects due to end reflection, vibration, flanking transmission, and standing waves in the reverberant room. Air flow and pressure loss measurements shall be made in accordance with applicable portions of ASME, AMCA, and ADC air flow tests.

.5 The Dynamic Insertion Loss in dB for silencers shall not be less than scheduled on the drawings.

.6 Silencers shall not produce self noise power levels in dB re: 10^{-12} watts than exceed those scheduled on the drawings.

.7 The Dynamic Insertion Loss and Generated Noise shall be for forward or reverse flow conditions in accordance with the system design.

.8 Silencer pressure drops shall not exceed those shown on the silencer schedule.

.9 Acceptable Manufacturer:
  .1 Vibro-Acoustics
  .2 Vibron

2.3 ENCLOSURES

.1 Type 1
  .1 Type 1 enclosure shall be field assembled using gypsum board on metal furring channels with glass fiber insulation between the furring channels. The assembly shall be screwed directly to the surface being treated.
  .2 The gypsum board layer shall consist of two(2) layers of ½" thick gypsum board. Joints shall be staggered. All joints shall be taped and grouted to form an air tight enclosure.
  .3 Furring channels shall be standard 1" metal furring channel.
  .4 Glass fiber insulation shall be 1" thick unfaced batt insulation.

2.4 ACOUSTICAL SEALANTS

.1 Acoustical sealant shall be permanently elastic latex, acrylic or silicone type caulking compound that will not stain the surrounding building material.

.2 Acoustical sealant shall be one of the following products or approved equal:
  .1 BA-98 - Pecora
  .2 Acoustical Sealant - Tremco
  .3 Acoustical Sealant - USG
  .4 Acoustical Sealant - DAP

Part 3 Execution

3.1 APPLICATION

.1 Silencer types and sizes are to be as scheduled on the drawings. The manufacturer of duct silencers shall review the location of duct silencers on the floor plans prior to preparation of the shop drawings. If the locations indicated on the floor plans result in increase in specified insertion loss, the manufacturer shall advise the contractor to relocate the duct silencer in accordance with manufacturer's recommendations at no extra cost.

.2 The combined air friction through the duct silencer and the system effect pressure losses shall not exceed the air friction listed in the schedule; the duct silencer shall not be smaller than the duct size. Provide larger duct silencers where required to keep the pressure drop including the system effect within the specified limit. When the duct silencers are larger than the duct, provide transitions in accordance with recommendations of duct silencer manufacturer.

.3 The ductwork between the duct silencer and mechanical room wall or floor slab to be enclosed as per details on the drawings. Division 15 shall be responsible for the complete enclosure including the drywall.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Provide samples of the following:
- .1 Flexible connections.
- .2 Sealants and tapes.
- .3 Duct access doors.
- .4 Turning vanes.
- .5 Instrument test ports.

1.2 CERTIFICATION OF RATINGS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 FLEXIBLE CONNECTIONS

.1 Frame: Galvanized sheet metal frame with fabric clenched by means of double locked seams.

.2 Material:
- .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minimum 40°C to plus 90°C, density of 1.3 kg/m2.

2.2 ACCESS DOORS IN DUCTS

.1 Non-isolated ducts: Sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm thick complete with sheet metal angle frame.

.2 Insulated ducts: Sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm thick complete with sheet metal angle frame and 25mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:
- .1 Up to 300 X 300mm: 2 sash locks c/w safety chain.
- .2 300 to 1000mm: piano hinge and minimum 2 sash locks.
- .3 Doors over 1000mm: piano hinge and 2 handles operable from both sides.
- .4 Hold open devices for doors over 1000mm.

2.3 TURNING VALVES

.1 Factory fabricated double thickness with trailing edge, torecommendations of SMACNA and as indicated.

2.4 INSTRUMENT TEST PORTS

.1 1.6mm thick steel zinc plated after manufacturer.

.2 Can lock handles with neoprene expansion plug and handle chain.

.3 28mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

.5 Acceptable Manufacturer:
  .1 Duro Dyne IPI or IP2, or equal.

2.5 DUCT SEALER

.1 Acceptable Manufacturer:
  .1 Cain: Duct Butter or Butter Tak
  .2 Duro Dyne: S2
  .3 Hardcast: Galv-Grip 251 or Peel-N-Seal AM 401 Tape
  .4 Kingco: 15-325
  .5 Mon-Eco: 44-41
  .6 United: Sheet metal duct sealer
  .7 Bakor: Duck Seal

Part 3 Execution

3.1 INSTALLATION

.1 Flexible Connections:
  .1 Install in following locations:
    .1 Inlets and outlets to supply air units and fans.
    .2 Inlets and outlets of exhaust and return air fans.
    .3 As indicated and as specified.

.2 Length of connection: 100mm.

.3 Minimum distance between metal parts when system in operation: 75mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:
  .1 Ducting on each side of flexible connection to be in alignment.
  .2 Ensure slack material in flexible connection.

.2 Access Doors:
  .1 Size:
    .1 600 X 600mm for person size entry.
    .2 600 X 600mm for servicing entry.
    .3 300 X 300mm for viewing.
    .4 As indicated and as specified.
  .2 Location:
    .1 At fire and smoke dampers.
    .2 At control dampers.
    .3 At devices requiring maintenance.
    .4 At locations required by code.
    .5 At reheat coils.
    .6 At intake plenums and exhaust plenums.

.3 Instrument Test Ports:
  .1 General:
    .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  .2 Locations:
    .1 For traverse readings:
      .1 At inlets and outlets of other fan systems.
      .2 At main & sub-main ducts.
      .3 And as indicated.
    .2 For temperature readings:
      .1 At outside air intakes.
      .2 In mixed air applications in locations as approved by Departmental Representative.
      .3 At inlet and outlet of coils.
      .4 Downstream of junctions of two converging air streams of different temperatures.
      .5 As indicated.

.4 Turning Vanes:
  .1 Install in accordance with recommendations of SMACNA and as indicated complete with Senior Bor Rail.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Do work in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible 1995, except where specified otherwise.

1.2 PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

Part 2 Products

2.1 SINGLE BLADE DAMPERS

.1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 200mm.

.3 Locking quadrant.

.4 Inside and outside end bearings.

2.2 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed Blade: Configuration to recommendations of SMACNA.

.3 Maximum Blade Height: 100mm.

.4 Bearings: Pin in bronze bushings.

.5 Linkage: Shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 INSTALLATION

.1 Install where indicated.

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

.3 For supply, return and exhaust systems, balancing dampers are to be located in each branch duct.

.4 Each grille, register and diffuser connection to have balancing damper located as close as possible to main ducts.

.5 Install splitter damper blade, pivot and control rod in rigid manner to prevent vibration.

.6 Review drawings with TAB Contractor and install balancing damper in locations chosen by TAB. Provide at no additional cost to Departmental Representative.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section applies to operating dampers not specified in other sections.

1.2 PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Indicate the following:
.1 Performance Data.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.4 MANUFACTURED ITEMS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

Part 2 Products

2.1 BACK DRAFT DAMPERS

.1 Automatic operated, multi-leaf, steel construction with nylon bearings, centre pivoted spring assisted or counter-weighted as indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Install where indicated.

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

.3 Seal multiple damper modules with silicon sealant.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Do work in accordance with CAN/ULC-S112-M90 (R2001), Standard Method of Fire Damper Assemblies, except where specified otherwise.

1.2 PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Indicate the following:
  .1 Fire dampers.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 FIRE DAMPERS

.1 Fire Dampers: Listed and bear label of ULC, meet requirements of NFPA 90A-1985.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.3 Top Hinged: Galvanized steel interlocking blades, guillotine type; sized to maintain full duct cross section.

.4 Fusible link, actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for horizontal position with vertical air flow.

.5 40 X 40 X 3mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Acceptable Manufacturer:
  .1 Controlled Air Type B and C

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with SMACNA Standard, NFPA 90A-1985 and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdictions.

.4 Install access door adjacent to each damper.

.5 Coordinate with installer of firestopping.

.6 Use Type C fire dampers on round ductwork.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Do work in accordance with the following standards except where specified otherwise:
- .1 CAN/ULC S110 for Fire Tests for Air Ducts.
- .2 UL 181 for Factory Made Air Ducts and Connectors.
- .3 ANSI/NFPA 90A for Installation of Air Conditioning and Ventilating Systems.
- .4 ANSI/NFPA 90B for Installation of Warm Air Heating and Air Conditioning systems.
- .5 SMACNA HVAC Duct Construction Standards - Metal and Flexible.

1.2 PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Indicate the following:
- .1 Thermal properties.
- .2 Friction loss.
- .3 Acoustical loss.
- .4 Leakage.
- .5 Fire rating.

1.3 CERTIFICATION OF RATINGS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.4 SAMPLES

.1 Submit samples with product data of flexible duct being used in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

Part 2 Products

2.1 GENERAL

.1 Factory fabricated to CAN/ULC 110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 FLEXIBLE DUCTWORK

.1 Comply with requirements of ULC "Standards for Safety, Air Ducts", ULC S110, and NFPA 90A.

.2 Spiral wound, flexible perforated aluminum duct of 6 mil thickness. Unit must withstand 2.5 kPa internal pressure.

.3 Thermally insulated ductwork: Flexible glass fibre, nominal thickness of 25mm factory applied, unless otherwise specified, with PVC exterior vapour barrier.

.4 Acceptable Manufacturer:
 .1 Trans Continental Acoustaflex Ductwork
 .2 A1-U-Flex Type A2
 .3 Flexmaster 2 ply insulated flexible duct
 .4 Thermaflex Type MKE

Part 3 Execution

3.1 DUCT INSTALLATION

.1 Locate between Terminal Units and all grilles, registers and diffusers.

.2 Support flexible ducts at 1200mm centers. Minimum of two hangers per length.

.3 Maximum length of flexible duct connections shall be 1800mm.

.4 Connections between flexible duct and terminal devices to be made airtight with duct tape.

.5 Use Stainless Steel Flexible Duct on all general exhaust grilles connected to the fume hood exhaust system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 AMCA 99-1986, Standards Handbook.

.2 ANSI/AMCA 210-1985, Laboratory Methods of Testing Fans for Rating.

.3 AMCA 300-1985 Revised 1987, Reverberant Room Method for Sound Testing of Fans.

.4 AMCA 301-1976, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.5 ANSI/ASHRAE 51-1985, Laboratory Methods of Testing Fans for Rating.

.6 CGSB 1-GP-181M-77, Coating, Zinc Rich, Organic, Ready Mixed.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product data to include fan curves and sound rating data, showing point of operation.

.3 Indicate the following: motors, wheels, bearings, shafts.

1.3 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.4 MAINTENANCE MATERIALS

.1 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.5 MANUFACTURED ITEMS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

.2 Provide confirmation of testing.

Part 2 Products

2.1 FANS GENERAL

.1 Provide with capacity, total static-pressure, revolutions per second, power, model and size and sound power level as indicated.

.2 Sound ratings shall comply with AMCA (Air Moving and Conditioning Association) 301-77 tested to AMCA 300-67. Unit shall bear the AMCA certified sound rating seal.

.3 Fans shall be statically and dynamically balanced, constructed in conformity with AMCA 2408-69.

.4 Base ratings on tests performed in accordance with AMCA 210-74, and ASHRAE 51-75. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300mm diameter.

.5 Bearings: equip with heavy duty grease lubricated ball or roller bearings of self aligning type with oil retaining, dust excluding seals and 200,000 h service in accordance with ANSI B3.15-1972 for ball bearings and ANSI B3.16-1972 for roller bearings and AFBMA (Anti-Friction Bearing Manufacturers Association) L-10 life standard.

  .1 Acceptable Manufacturers:
    - SKF
    - NTN Seal Master
    - Timken
    - FAG

  .2 Provide bearing lubrication system and extended lube lines on all fans.

.6 Provide electric motors as indicated.

.7 Provide accessories and hardware including V-belt drives, adjustable slide rail motor bases, fan section enclosure, dampers and vanes. Provide access holes in all belt guards for tachometer readings.

.8 Factory prime in colour standard to manufacturer. Paint before assembly.

.9 Fan selections are based on manufacturer named in the schedule. The approval of equipment of other manufacturers named in the acceptable materials list shall be subject to meeting the performance and sound power levels. If the sound power levels as noted are exceeded, the fan manufacturer shall be responsible for the additional attenuation and the resulting changes in fan static and motor size. The fan manufacturer shall also be responsible for all electrical changes caused by the change in motor size.

2.2 CENTRIFUGAL FANS

.1 Fan Wheels:

  .1 Welded steel construction.

  .2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.

.3 Double thickness air foil backward inclined blades, unless otherwise specified.

.2 Housing:
.1 Form volute with inlet cones, fabricated steel for wheels 300mm or greater, steel, for smaller wheels, braced, and with welded supports. Convertible discharge up to 675mm wheels, fixed discharge for larger.
.2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
.3 Provide airtight access doors with handles.

.3 Acceptable Manufacturers:
- Sheldons Unifoil and Ultrafoil
- Trane
- Barry Blowers
- Chicago Blower
- Northern Blower
- Greenheck
- Cook
- Twin City

2.3 CABINET FANS

.1 Single wheel with DWDI centrifugal fans in factory fabricated casing complete with motor, V-belt drive and guard inside and outside casing.

.2 Fabricate casing of zinc coated or phosphate treated steel of 18 ga. thickness reinforced and braced for rigidity. Provide removable panels for access to internal parts. Uncoated, steel parts shall be painted over with corrosion resistant paint to CGSB-1-GP-181M.

.3 Cabinets of the fans for Supply Air Units shall be lined with 50mm thick neoprene coated rigid duct liner of 1.5 lbs/ft^3 density. Duct liner shall be covered with 20 ga. thick solid galvanized sheet steel. All duct liner joints shall be coated with approved fire resistant adhesive. Use sheet metal corners to cover all duct liner edges.

.4 Provide man-size gasketed and sandwich-panel access doors on one side of the cabinet.

.5 Acceptable Manufacturers:
- Barry Blower
- Chicago Blower
- Northern Blower
- Greenheck
- Cook
- PennBarry
- Acme

2.4 IN-LINE FANS (MIXED FLOW)

.1 Casing: Welded steel, welded motor support, bolted access plates, spun inlet ring for stream-lined flow to wheel spin shroud and back plated.

.2 Fan wheel dynamically balanced. Bearings regreasable through external nipples. Fans to have fixed blades and be externally mounted integral motor through V-belt drive. Provide internal and external drive guards and adjustable motor mounts.

.3 Acceptable Manufacturers:
- Sheldons Type MF In-Line Fans
- Trane Model Q In-Line Fans
- Barry Blowers ES1
- Greenheck QEI
- Cook

2.5 PLENUM FANS

.1 Plenum Fans shall be of the centrifugal type with backward inclined wheels on fan sizes 12-16 and airfoil wheels on fan sizes 18-73.

.2 Bearing supports shall be constructed of welded structural steel members to prevent vibration and to rigidly support the fan shaft and bearings.

.3 The fan wheel shall be of the non-overloading backward inclined centrifugal type. Wheels shall be statically and dynamically balanced before installation in the fan. After assembly each fan shall be given an electronic vibration analysis while running at the specified operating RPM. Vibration amplitude and frequency shall be recorded in the horizontal, vertical and axial planes of each bearing to assure smooth vibration free operation. The analyzer print-out shall be filed and made available upon customer request.

.4 Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.

.5 Bearings shall be heavy-duty grease lubricated, self-aligning ball or roller pillow block type. Bearings shall be selected for a basic rating fatigue life (L-10) per AFBMA Standards in excess of 80,000 hours at maximum operating speed for each pressure class.

.6 Fan performance shall be based on tests and procedures performed in accordance with AMCA Publication 211 and Publication 311 and comply with the requirements of the AMCA Certified Ratings Program. Fans shall be licensed to bear the AMCA Seal.

.7 Acceptable Manufacturers:
- Greenheck
- Cook
- Twin City
- Cook

Part 3 Execution

3.1 FAN INSTALLATION

.1 Install fans as indicated. Complete with resilient mountings and flexible electrical leads.

.2 Install flexible connector bands between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 25mm flex between ductwork and fan during running.

.3 Install fan restraining snubbers where indicated on drawings. Flex connectors shall not be in tension during running.

.4 Provide sheaves required for final air balance.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Fans shall have been tested under AMCA 210-85, Laboratory Methods of Testing Fans for Rating, or British Standard 848, Part 1, "Methods of Testing Performance, 1980, and shall have been witnessed by an independent agency.

.2 Documented aspiration tests shall have been performed in conjunction with the fan performance test.

.3 Sound testing shall be in accordance with AMCA 300.

.4 Fan shall be UL and CUL listed per UL 705 safety standard.

.5 Fans shall meet the criteria of NFPA-45.

1.2 SUBMITTALS

.1 Submit shop drawings and product data sheets including performance data, fan curves, and sound power levels in accordance with Section 01 33 00 – Shop Drawings and Other Submittal Procedures.

.2 Fan manufacturer shall furnish a certificate of guarantee stating that the fan, mixing plenum, outlet nozzle, stack extension and silencer and all related accessories specified herein have been pre-tested at the factory and that the curves supplied in 1.2.1 have been de-rated for any and all system effects created by the accessories.

1.3 OPERATING AND MAINTENANCE MATERIAL

.1 Submit operating and maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 MIXED FLOW INDUCED DILUTION HIGH-PLUME FANS

.1 Mixed-Flow Induced Dilution Fans:
- .1 Impellers shall be mounted directly to the motor shaft to provide a direct drive arrangement 4 type fan. Motors shall isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.
- .2 Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with stable operation at any point on the fan curves.
- .3 Stationary discharge guide vane sections shall be provided to increase fan efficiencies.

.4 Fan dynamic balance not to exceed 0.5 mil, peak to peak, at the blade pass area when operating at fan frequency. Vibration isolation shall be limited to rubber-in-shear pad type isolators.

.5 Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports.

.6 Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant. Silencer discharge nozzle shall be constructed with 3/16" thick fiber reinforced plastic outer wall, sound attenuating fibreglass packing isolated from the air stream with Tedlar liner under perforated stainless inner wall. Attenuator's height shall be Standard to manufacturer and shall meet insertion losses as follows: 0/4/9/11/12/13/9/4 dB.

.7 Steel entrainment windbands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Windbands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow. Fan performance shall include for effects of silencer nozzles, side inlet configuration, plenum, and dual fan arrangement on air flow, static pressure and sound power levels.

.8 A non-ferrous inlet bell shall be provided in order to reduce sparking in the event of a motor bearing failure.

.9 Fans shall be modular construction and capable of being assembled on the roof.

.10 PTFE gaskets shall be provided at all companion flanged joints.

.11 Fasteners shall be 316 stainless steel.

.12 A bolted access door shall be provided for impeller inspection on each fan.

.13 Fans and accessories shall have internal drain systems to prevent rain water from entering building duct system.

.14 Electric motors shall be TEFC Mill & Chemical duty with a 1.15 service factor and an L-50 bearing life of 200,000 hours. Motors shall have sealed bearings up through a 256T NEMA frame. Motors shall be premium efficiency (NEMA 12-12, VFD rated.

.15 A NEMA 3R non-fused disconnect switch shall be provided, mounted and wired to the motor.

.16 Coatings-All steel and aluminum surfaces shall be prepared for coating by blasting or chemical etching. Coating will be Epoxy (8-10 mils) for protection against weather, chemical vapors and splashes.

2.2 ACCESSORIES

.1 Low leakage isolation dampers shall be constructed of aluminum air foil extrusions and coated with epoxy. Operators shall be 2 position, spring return and shall be 24V electric. The electric operator shall be factory wired via a transformer to the fan disconnect switch to open when the fan is energized and close via a spring return when de-energized. When the fan ships separate from the plenum, all wiring and conduit shall be factory supplied for easy connection in the field. Damper actuators shall be fast response (15 second full stroke cycle) equipped with position switches of signal for tie in by EMCS to monitor whether open or closed.

.2 Vortex breakers shall be provided on all side inlet and multiple fan plenums.

.3 A 14 gauge galvanized steel insulated roof curb shall be provided to support the fans/plenums. The curb shall be minimum 14 gauge and canted for rigidity in wind loads. The curb shall be 350 mm (14”) high. The curb shall include a rigid fiberglass liner and a wood nailer.

.4 Motor cover with hinged removable access panel.

.5 Weatherhood over bypass damper complete with inlet screen.

.6 Extended lube lines (Nylon).

.7 Isolation damper.

2.3 STANDARD OF ACCEPTANCE

.1 Greenheck Vector Mixed Flow

.2 Strobic Air Tri-Stack Fume Exhaust Systems.

Part 3 Execution

3.1 INSTALLATION

.1 Install unit on existing curb in accordance with manufacturer's recommendations.

3.2 COMMISSIONING

.1 Manufacturer to send factory trained technician to oversee installation, start-up and Owner-demonstration of exhaust systems.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ANSI/NFPA 90A, Air Conditioning and Ventilation Systems.

.2 UL 181-1981, Factory-Made Air Ducts and Connectors.

1.2 SHOP DRAWING AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Indicate the following:
- .1 Capacity.
- .2 Pressure drop.
- .3 Noise rating.

1.3 TEST REPORTS

.1 To AMCA 210. Submit published test data on DIL, in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity. Sound power level with minimum inlet pressure of 250 Pa in accordance with ISO 3741 for 2nd through 7th octave band, also made by Air Diffusion Council. Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

1.4 MAINTENANCE DATA

.1 Provide maintenance data for incorporation manual specified in Section 01 78 00 – Closeout Submittals.

1.5 MANUFACTURED ITEMS

.1 Terminal units shall be product of one manufacturer for generic type.

1.6 CERTIFICATION OF RATINGS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 DDC VARIABLE AIR VOLUME DUAL-DUCT BOXES

.1 Pressure independent, reset to air flow between zero and maximum air volume.

.2 At inlet velocity of 553 m/min, differential static pressure not to exceed 25 Pa.

.3 Sound ratings of assembly not to exceed 32 NC at 250 Pa.

.4 Electronic field actuators installed by control contractor.

.5 Casing: Constructed galvanized steel, internally lined with 25mm, 0.7 kg density fibrous glass, which is in accordance with UL 181 and NFPA-90A. Mount control components inside protective metal shroud.

.6 Damper: Steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.

.7 Sizes and Capacity: as indicated.

.8 Standard of Acceptance:
.1 E.H. Price DDUQ Ultra-Quiet Dual-Duct Terminal Unit c/w Integral Silencer.

.9 Acceptable Alternates: Titus, Nailor.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer recommendations.

.2 Support independently of ductwork.

.3 Install with minimum of five duct diameters of straight inlet duct, same size as inlet.

3.2 START-UP AND COMMISSIONING

.1 Provide start-up and Commissioning as required.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 Door grilles: Supplied by this Section, installed by Division 8.

1.2 PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Shop Drawings and Other Submittal Procedures.

.2 Indicate the following:
.1 Capacity
.2 Throws
.3 Noise criteria

1.3 MAINTENANCE MATERIALS

.1 Include: maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.
.1 Keys for volume control adjustment.
.2 Keys for air flow pattern adjustment.

1.4 MANUFACTURED ITEMS

.1 Grilles, registers and diffusers shall be product of one manufacturer for generic type.

1.5 CERTIFICATION OF RATINGS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 GENERAL

.1 Standard product to meet capacity, throw, noise level, throat and outlet velocity as indicated.

.2 Use concealed operators.

.3 Sizes indicated are nominal. Provide correct standard product nearest to nominal for capacity throw, noise level, throat and outlet velocity.

.4 Furnish factory prime coated steel frames for setting into fire protecting membrane. At aluminum diffusers, registers and grilles, provide 1.2mm thick minimum steel collar up to fire damper or fire stop flap, for suspending from the basic structure independently of membrane pierced to maintain fire protection membrane integrity.

.5 Where penetrating fire partitions, provide approved steel sleeve attached to structure and secured in accord with NFPA 90A. Where penetrating fire walls provide 3.4mm thick steel sleeve with angle iron perimeter frame to NFPA 90A.

.6 Frames:
- .1 Steel: Standard cold rolled steel with exposed joints welded and ground flush and completely closed.
- .2 Aluminum: Satin finish with mechanical fasteners and completely closed corners.
- .3 Provide full perimeter sponge rubber gaskets.
- .4 Provide plaster frames as plaster stops set into gypsum board at all locations.
- .5 Provide concealed fasteners and operators.

.7 Finish:
- .1 Off white baked enamel unless otherwise indicated.

2.2 CEILING SUPPLY DIFFUSER

.1 Type A – Radial Flow Laboratory Diffuser
- .1 Extruded aluminium Construction.
- .2 Flush Face radial flow diffuser, two way non aspirating, low velocity air pattern.
- .3 Constructed of air deflection blades below an equalization baffle, with a perforated face. Round duct inlet connection.
- .4 Diffuser to have a radial, Non-Aspirating, Low velocity air pattern.
- .5 Quick release latches and higes for room-side cleaning.
- .6 Acceptable Manufacturers:
  - .1 Price AFD/2W/B12
  - .2 Titus Tritec-AL
  - .3 Nailor

.2 Type B – Supply Diffuser
- .1 Square diffuser of three core configuration and aluminium construction.
- .2 Inner cones to be completely removable.
- .3 Face size and neck size of diffuser to be as per schedule on drawings.
- .4 Acceptable Manufacturer:
  - .1 Price ASCD/BI2
  - .2 Titus TMS-AA
  - .3 Nailor ARNS

2.3 SIDEWALL SUPPLY GRILLES/REGISTERS

.1 Type A – Supply Registers
- .1 Double deflection supply register of aluminium construction with integral opposed blade damper.
- .2 Front blades to run parallel to long dimension of register.
- .3 Registers shall be fully adjustable with two sets of deflection blades and spaced 19mm on centre.
- .4 Acceptable Manufacturer:
  - .1 Price 620 D/F/B12.
  - .2 Titus 300F
  - .3 Nailor 51DV

.2 Type B – Supply Grille
  .1 Double deflection supply grille of aluminium construction.
  .2 Front blades to run parallel to long dimension of grille.
  .3 Grilles shall be fully adjustable with two sets of deflection blades spaced, 19mm on centre.
  .4 Acceptable Manufacturer:
    .1 Price 620/F/B12.
    .2 Titus 300F
    .3 Nailor 51DV

2.4 RETURN/EXHAUST CEILING GRILLES/REGISTERS

.1 Type A – T-bar lay in Return/Exhaust Grille
  .1 Perforated face exhaust grille of aluminium construction.
  .2 Grilles to consist of perforated core 5mm diameter holes on 6mm centres staggered 60° with extruded aluminum frame.
  .3 Grilles to have 25mm T'bar lay-in border.
  .4 Grille to be finished in White, powder coat finish.
  .5 Acceptable Manufacturer:
    .1 Price 10A/TB/B12.
    .2 Titus 8F/2/26
    .3 Nailor 61PR

.2 Type B – Return/Exhaust Register
  .1 Fixed louver, airfoil blade return/exhaust register of aluminium construction with 32mm curved border and counter sunk screwholes.
  .2 The blades shall be 45° deflection and spaced 19mm on centre with the blades orientated parallel to the long dimension.
  .3 Register to be complete with opposed blade damper of aluminium construction.
  .4 Register to be finished in white powder coat.
  .5 Acceptable Manufacturer:
    .1 Price 60 DAL/C/L/B12.
    .2 Titus 3FL
    .3 Nailor 7145

.3 Type C – Perforated Face Return Grille
  .1 Perforated face return grille of aluminium construction.
  .2 Grilles shall consist of perforated core, 5mm diameter holes on 6mm centres staggered 60° with extruded aluminium frame.
  .3 Grilles shall have 32mm flat border with counter sunk screwholes.
  .4 Grilles to be finished in white powder coat finish.
  .5 Acceptable Manufacturer:
    .1 Price 10A/F/B12.
    .2 Titus 8F/1/26
    .3 Nailor 61PR

2.5 SIDEWALL EXHAUST GRILLES/REGISTERS

.1 Type A – Louvered Exhaust Register
 .1 Fixed louver exhaust register of aluminum construction with integral opposed blade damper.
 .2 Blades shall be spaced 19mm on centre and have 45° deflection.
 .3 Blades shall run the long dimension of the register.
 .4 Register shall have 32mm flat border with counter sunk screwholes.
 .5 Register shall be finished in white powder coat.
 .6 Acceptable Manufacturer:
  .1 Price 630D/F/B12
  .2 Titus 350FL
  .3 Nailor 5145

.2 Type B – Louvered Exhaust Grille
 .1 Fixed louver exhaust grille of aluminum construction.
 .2 Blades shall be spaced 19mm on centre and have 45° deflection.
 .3 Blades shall run parallel to the long dimension of grille.
 .4 Grille shall have 32mm flat border with counter sunk screwholes.
 .5 Grilles shall be finished in white powder coat.
 .6 Acceptable Manufacturer:
  .1 Price 630/F/B12.
  .2 Titus 350FL
  .3 Nailor 5145

2.6 LINEAR SUPPLY DIFFUSER

.1 Type A – Linear Slot Supply Diffuser
 .1 Linear slot supply diffuser of solid extruded aluminium construction.
 .2 Slots shall have 100mm spacing with 180° air pattern adjustment.
 .3 Number of slots as per schedule on drawings.
 .4 Active length of diffuser as per mechanical ventilation plans. Total length as per architectural reflected ceiling plans.
 .5 Diffuser shall be complete with 29mm surface mount frame with counter sunk screwholes.
 .6 Provide mitred type flange and drywall insulated plenum as required.
 .7 Diffuser shall be finished in white powder coat or aluminium clear coat as per schedule.
 .8 Acceptable Manufacturer:
  .1 Price SDS100/1/XX/B12.
  .2 Titus ML39
  .3 Nailor 5000

.2 Type B Linear Bar Grille:
 .1 Bar type grille of extruded aluminium construction.
 .2 Code bars parallel to long dimension.
 .3 Border 25mm wide with mitred corners.
 .4 3mm wide bar spacing with 0° deflection.
 .5 Finished in aluminum clear coat.

.6 Acceptable Manufacturer:
  .1 Price LBP 15B
  .2 Titus CT
  .3 Nailor 4900

2.7 DOOR GRILLES

.1 Type A Door Grilles:
  .1 Extruded aluminum construction.

.2 Acceptable Manufacturers:
  .1 Price Model ATGH.
  .2 Titus CT7000
  .3 Nailor 51DG

.3 Where grilles are located in fire rated doors/walls use listed fire dampered door grilles. Refer to Door Schedule.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Fit frame with gasket to prevent leakage and smudging.

.3 Install with cadmium plated screws in countersunk holes where fastenings are visible.

.4 Connections to lay-in supply diffusers may be made with flexible duct. All connections to supply diffusers in drywall ceilings and all return and exhaust grilles must be made with rigid ductwork.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Refer to General, and Special Conditions for other requirements included and outlined in other sections of the specifications.

1.2 REFERENCES

.1 Public Works and Government Services Canada (PWGSC).
  - .1 PWGSC MD15128-2006, Perchloric Acid Fume Hoods and Their Exhaust Systems.
  - .2 PWGSC MD15126, Minimum Guidelines for Laboratory HVAC and Exhaust Systems.

1.3 SCOPE OF WORK

.1 Provide all labour, materials, facilities, equipment and services to thoroughly clean the ductwork and fans for the supply air systems and all the related fume hood exhaust and general exhaust air systems installed in this contract.

.2 The cleaning work shall include but not be limited to the following:
  - .1 All supply, fume hood and exhaust ductwork.
  - .2 All related to AHU 5A and 5B diffusers and grilles.
  - .3 Return and exhaust fans.
  - .4 Supply air units 5A and 5B including the unit enclosure, heating and cooling fans and drain pans, etc.
  - .5 Outside air intake plenums and exhaust air plenums.
  - .6 All fume hood duct work and perchloric acid fit duct work must be cleaned prior to any redundant duct removals.

.3 Provide all labour and services to obtain access to HVAC Systems and associated components including removal of ceiling tiles.

.4 Replace or repair any damage to mechanical components, ceilings or walls caused during the duct cleaning.

.5 Scope of work to include the following:
  - .1 Carry out field inspection and review to determine the method of cleaning the HVAC systems and its components. Submit to the Consultant, the proposed methods for cleaning and their efforts to the system.
  - .2 Reset all balancing dampers to original settings if moved during cleaning. Be sure to mark original position so that during the final inspections original settings can be field verified.
  - .3 Report to the Consultant, any system defects discovered during the cleaning operation (e.g., equipment, ductwork, dampers, registers, etc.).

1.4 QUALITY ASSURANCE

.1 Ductwork shall be cleaned in compliance with mechanical cleaning of Non-Porous Air Conveyance System Components NADCA 1992-01.

.2 All duct and fan system surfaces must be visibly clean and capable of passing the NADCA vacuum test. The weight of debris collected by the NADCA Vacuum Test as outlined in Appendix "A" shall not exceed 1.0 mg/100cm^2.

Part 3 Execution

3.1 PRE-CLEANING PREPARATIONS

.1 Prior to start of work, the HVAC system is to be carefully inspected and checked for all conditions affecting the cleaning. Defects are to be reported in writing to the Consultant and work will not proceed until defects have been documented.

.2 Fire protection devices such as smoke detectors, etc. shall be protected prior to cleaning procedures.

.3 The contractor shall have samples collected by gathering the gross debris from the surface of the duct at a minimum of three (3) locations per system prior to and after cleaning. This shall be accomplished by utilizing protective clean surgical gloves to handle the surface debris. A 100 cm^2 area shall be scraped and the debris placed in a 4 oz. sterile container with screw cap. The container shall be adequately marked as to sample location, date and time. The total weight will be established per 100 cm^2.

.4 Cleaning to be performed prior to “bumping” of fans.

3.2 CLEANING AND REMOVAL METHOD

.1 The following general ductwork cleaning procedures are to be used as a guideline. Determine which method should be used in each area and submit detailed description of the procedures to the Consultant.

.2 Debris Collection Equipment:

   .1 Equipment used shall be portable and sized to enter the areas easily. Electrical requirements shall be the responsibility of the cleaning contractor.

   .2 The collection system shall be self-contained units, with the appropriate components to adequately collect dirt and debris loosened from the ductwork. Air duct cleaning is to be performed by a high powered vacuum system with three stages of filtration. The final stage to be a HEPA filter.

   .3 The collection system shall be capable of producing a minimum of 0.42" water gauge negative static pressure and 0.25" water gauge velocity pressure in the area of ductwork to be cleaned.

.3 Agitation Equipment:

.1 Air power cleaning of all interior ductwork, fan housings and HVAC units performed by a high pressure compressed air system which will be directed through small access doors in the ductwork. The size and the number of access doors required for cleaning shall be determined by this Section and the access doors shall be as per Section.

.2 Air powered lances, extended whip sections or oscillating brush systems shall be used as a means of dislodging the debris.

.3 Where ductwork is large enough and able to support the weight of a worker, hand tools and vacuum may be used. If workers enter the inside of the duct they must follow the OSHA confined space requirements.

.4 Open Ductwork: During the cleaning process, provide temporary closure of metal or taped polyethylene on open ductwork to prevent the dust during the cleaning process from dispersing throughout the work area.

.5 Debris removed during the cleaning process shall be collected and tagged as to its origin within the duct system.

.6 Air Handling Unit Surfaces:

.1 The interior of air handling units shall be brushed and mechanically vacuumed such that all metal surfaces are visibly clean.

.2 Air handling cleaning shall include all plenums, filter sections, mixing boxes, access sections, etc.

.7 Coils shall be vacuumed such that they are visibly clean. Coil drain pans shall be subject to cleaning as per NADCA standards.

.8 Volume and Fire Dampers: Duct mounted volume and fire dampers are to be marked to their current settings and cleaned if necessary.

3.3 CLEANING AND DE-COMMISSIONING PERCHLORIC ACID SYSTEMS

.1 Approach to De-commissioning.

.1 A properly designed constructed, and operated perchloric acid system is likely to have minimal perchlorates present in any of the components. However, it is important to note that in some laboratories, perchloric acid fume hoods may have been in use even when certain of the components of the system were not functioning properly, or proper wash down was not happening. If this is the case, shock sensitive perchlorates may be present.

.2 Accidents can take place during maintenance or removal of perchloric acid systems. The uncertainty of the degree of danger required that precautions be observed. When in doubt one must assume that the fume hood, ductwork, and exhaust fan contain unstable, explosive residues.

.3 De-commissioning Sequence:

.1 Wetting the entire system.

.2 Testing for perchlorates.

.3 Removal of the system (while continuing to wet)

.4 De-commissioning the components.

.5 Final testing to confirm that the materials are “clean”.

.2 Procedures – Maintenance and De-Commissioning

.1 De-commissioning procedures must not be initiated until the perchloric acid fume hood and exhaust system have been tested for the presence of perchlorates. Such testing can commence after all surfaces have been wetted.

.2 The use of ballistic gear is recommended if aggressive manipulation of the system is conducted. The gear should consist of fire-retardant coveralls, ballistic vest/faceshield/helmet, and personal protective equipment such as gloves and shoe covers.

.3 Wetting of surface

.1 A well designed, properly constructed/commissioned, consistently used washdown system has the ability to maintain a perchloric acid fume hood and its ductwork in a safe condition. If such a system does not exist of if there is anydoubt regarding its effectiveness, then a supplemental method of wetting internal surfaces must be provided.

.2 The primary reason for initial wetting of th system is for safety rather than for decontamination (Note that extensive wetting otr steaming is not necessarily successful in removing all perchlorates) Option wetting methods include:

.1 Steaming the system for 24 hours in order to condense moisture in every possible location, or,

.2 Introduce a fine mist of water within the fume hood while the exhaust fan is running. The high humidity air stream will wet all surfaces in the system. Such wetting should be continued for a period of at lest 12 hours, or,

.3 Any other wetting method which will assure prolonged water contact with all internal surface.

.3 For all these option, if the ductwork is welded (rather than flanged and gasketted), and if the system is in relatively sound condition, the persistent washing down and testing/re-testing of the rinsate is thought to be judicious approach in rendering the system less hazardous to work on. (If tests after 12 hours show perchlorates in the final wash water, the misting should be continued for another 12 hours or until the test is negative.)

.4 For older, deteroriated systems (possibly with flanged duct connections) wha=ich are to be removed, initial wetting is required, but there should be no exception that persistent washing will render the system safe. IN this instance, after testing for perchlorates, the system is continuously wetted while it is removed piece-by-piece, submerged in a de-contamination water bath, and held there until all perchlorates have been dissolved. Use only clean cold water, without detergents or other chemical for wetting and washing procedures.

.4 Testing for perchlorates.

.1 Tests shall be conducted on the fume hood and exhaust system for explosive perchlorates prior to any inspection, cleaning, maintenance, demolition or other physical intervention. Only competent laboratory personnel or laboratory testing companies shall perform these tests.

.2 There are several test methods that have been used to establish the presence or absence of perchlorates. Two of these require that a water mist is sprayed into the hood, fan, and ductwork, and the rinsate collected.

.1 Methylene blue: - the rinsate is introduced onto 0.3% methylene blue solution (25ml of rinsate per several drops of indicator solution). IF perchlorates are present, a violet precipitate will be formed. Proceed to Ion Chromatography to analyze subsequent samples. Note: False positives and false negatives have occasionally beenreported using this method, and are thought to be related to the concentration of perchlorates falling outside the optimum range for this test. Use this test with caution and only under the supervision of an individual who is expert in analyzing the results. It may be used as an indicator, but its results should not be used as an absolute determinant, particularly for decommissioning work.

.2 Ion chromatography: - the rinsate is collected then sent to a lab for analysis by ion chromatography to determine the concentration of perchlorates. This test is considered the ultimate, definitive test for concentration of perchlorates, but it involves delays associated with lab testing.

Two other tests require that the surface(s), joints, etc. to be tested are accessible:

.3 Ion Selective Electrodes/Swab test: - swab potentially contaminated surfaces with damp gauze, and place these pads into water. A perchloric acid standard curve is prepared from a stock solution, and a specific ion (perchlorate) electrode is used to compare the swab unknowns against the concentrations in the standard curve. This test is the preferred, most practical, field test.

.4 Diphenylamine: - dissolve one gram of diphenylamine in 10ml of 1-to-1 (18 normal) sulfuric acid to form a diphenylamine sulfate solution. Use a medicine dropper to apply this solution to the test surface. The liquid turns black upon contact with perchlorate. (The solution also reacts with nitrates, but turns blue in that instance.)

.3 The results of these tests will act as a guide to the anticipated extent of perchlorate contamination of the system. With this, informed decisions can be made throughout the de-commissioning process. For Instance, heavily contaminated systems will require a thorough work plan and extreme caution in all activities during the de-commissioning process.

.5 Intervention and Dismantling Precautions

.1 The following procedures are recommended:

.1 Provide training to the participants by qualified individual. Instruction will alert workers to the danger, indicate methods of mitigation, and described activities, equipment, protective gear, and procedures to be followed.

.2 Prepare a planning exercise that clearly delineates the steps required, roles and responsibilities specific to the task at hand.

.3 Performa maintenance o r de-commissioning on weekends or silent hours only, when the laboratory facility is empty of personnel.

.4 Provide suitable isolation, barricades, and protective clothing for personnel.

.5 Avoid friction between components heating, sparks or shock (impact) from any source. Even the simple act of loosening nuts and bolts has the potential for explosion.

.6 Rather than dismantling joints, cut into ductwork away from joints, elbows, or any other area where higher concentrations of perchloates would be expected.

.7 Prior to any dismantling, extensive wetting (see section 3.3.4) and rinsate testing to confirm the absence of perchlorates in the rinse water is required. Dismantling activities should immediately follow such wetting of all surfaces.

.8 Using non-sparking tools (shears), dismantle fan manageable lengths of ductwork. Invasive activities such as cutting or drilling should be done under a continuous flow of water.

.9 Wash all disassembled. Parts.

.10 Only when tests confirm that no perchlorate residue exists in the rinsate from the disassembled parts, may they be sent to landfill or metal recycling. The objective is to dispose of all ductwork as a non hazardous waste.

.11 Although the rinsate will normally not have an acidity level of concern, the use of small quantities of biocarbonate may be used as a precautionary neutralizing procedure.

.6 These procedures are to be carried out by an outside contractor, that is carrying adequate general liability insurance. Contractors must supply proof of previous experience in-de-commissioning perchloric acid system.

3.4 VERIFICATION

.1 General verification of cleanliness will be determined after the completion of cleaning process.

.2 All duct and air handling unit surfaces must be visibly clean and capable of passing the NADCA vacuum test.

.3 The weight of debris collected by the NADCA vacuum test shall not exceed 1.0 mg/100cm^2.

.4 The contractor shall include the cost of four (4) vacuum tests per fan system in the new building to be performed at the time and location as directed by the Consultant. If any areas fail, the system of the failed test shall be recleaned and retested at no cost to the Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 05 93.13

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI/ASHRAE 110-1995, Method of Testing Performance of Laboratory Fume Hoods
.2 ANSI/AIHA Z9.5-2003, Laboratory Ventilation

.2 ASTM International

.1 ASTM A167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.2 ASTM A1008/A1008M-12, Standard Specification for Steel, sheet. Cold Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
.3 ASTM B456-11e1, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
.4 ASTM E84-12b, Standard Test Method for Surface Burning Characteristics of Building Materials.

.3 Canadian General Standards Boards (CGSB)

.1 CAN/CGSB-12.1- M90, Tempered and Laminated Safety Glass.

.4 CSA International

.1 CSA B651-12, Accessible Design for the Built Environment.
.2 CAN/CSA-C22.2 No. 61010-1-12, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.
.3 CSA W48-06(R2011), Filler Metals and Allied Materials for Metal Arc Welding.

.5 National Fire Protections Association (NFPA)

.1 NFPA 45-2011, Standard on Fire Protection for Laboratories Using Chemicals.

.6 National Plumbing Code of Canada 2010.

.7 Public Works and Government Services Canada (PWGSC).

.1 PWGSC MD15126, Minimum Guidelines for Laboratory HVAC and Exhaust Systems.
.2 PWGSC MD15128 2008, Laboratory Fume Hoods.
.3 PWGSC CP.1 to CP.13 – 2003, Commissioning Manuals and Guidelines.

.8 Scientific Furniture and Equipment Association (SEFA).

.1 SEFA 1 – 2010, Recommended Practices for Laboratory Fume Hoods.
.2 SEFA 2 – 2010, Recommended Practices for Installations.
.3 SEFA 3 – 2010, Recommended Practices for Laboratory Work Surfaces.
.4 SEFA 7 – 2010, Recommended Practices for Fixtures.

.9 Underwriter Laboratories of Canada (ULC)

.1 UL 723-08, Tests for Surfaces Burning Characteristics of Building Materials.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Co-ordination: co-ordinate work of this Section with work of other trades for proper time and sequence to avoid construction delays.

.2 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning on-site installation, with contractor's representative Departmental Representative, Representative. to:
.1 Verify project requirements.
.2 Review installation and substrate conditions.
.3 Co-ordination with other building construction subtrades.
.4 Review manufacturer's written installation instructions and warranty requirements.
.2 Notify attendees 1 weeks prior to meeting and ensure meeting attendees include as minimum:
.1 Departmental Representative.
.2 User Group.
.3 Manufacturer's Technical Representative.
.3 Ensure meeting agenda includes review of methods and procedures related to fume hood installation including co-ordination with related work.
.4 Record meeting proceedings including corrective measures and other actions required to ensure successful completion of work and distribute to each attendee within 1 week of meeting.

1.4 ACTION AND INFORMATION SUBMITTALS

.1 Submit in accordance with Contract Conditions and Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer’s instructions, printed product literature and data sheets for fume hood components and accessories and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit list of fume hood materials, components and accessories to be incorporated into Work.
.3 Include product names, types and series numbers for fume hood components and accessories.
.4 Include contact information for manufacturer for fume hood components and accessories used on this Project.
.5 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29 Health and Safety Requirements, 01 35 43 – Environmental Procedures.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Nova Scotia, Canada.

.2 Include on drawings:
.1 Materials and profiles and provide full-size, scaled details of components for each type of fume hood.
.2 Details of construction with dimensions, cross sections, and adjacent equipment.
.3 Roughing-in dimensions for plumbing, laboratory services, and electrical.

.4 Samples:

.1 Submit duplicate service fixtures with corrosion resistant finish.
.2 Submit sample of filter for use in fume hoods located in radioisotope laboratories.
.3 Submit 100 mm x 100 mm samples of interior and exterior surface finishes, and of work surface.
.4 Submit sample of airflow monitor/alarm.

.5 Test and Evaluation Reports:

.1 Submit detailed performance reports in accordance with PWGSC MD15128, fume hood design criteria and materials thickness. Include hood superstructure details.
.1 Indicate exhaust air flow rate.
.2 Indicate pressure drop through fume hood.

.6 Field Reports: Submit manufacturer’s field reports within 3 day of manufacturer representatives’ site visit.

1.5 CLOSEOUT SUBMITTALS

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

.2 Supply operations and maintenance data for incorporation onto manual specified in 01 78 00 – Closeout Submittals.

.1 Submit information for instructions for safe and proper operation of fume hoods. Include:
.1 Written instructions booklet showing additional information on safe, proper operation and maintenance, components parts list, and nearest local manufacturer’s representative for components and emergency repairs.

.3 Record Documentation:

.1 Submit list of materials used un fume hood work.
.2 Submit methodology for sealing joints.

.4 Warranty: Submit warranty documents specified.

.5 Acceptance verification check sheet.

.6 Operator Training Guide: Provide digital training presentation, highlighting proper operating practices of laboratory fume hood.

1.6 MAINTENANCE MATERIAL SUMITTALS

.1 Supply special tool for opening sash beyond normal opening position.

1.7 QUALITY ASSURANCE

.1 Fume hood, components and accessories to be manufactured by single manufacturer.

.2 Manufacturers will only be approved for this project after verification is made of fume hood test facility at manufacturer’s factory location.

.1 Testing facility to comply with ANSI/ASHRAE 110 requirements.
.2 Ensure data readings are digitally recorded and raw data submitted in electronic format approved by Departmental Representative.

.3 Provide and construct mock-ups in accordance with Section 01 45 00 – Quality Control.

.4 Certification: submit catalogued or published certified ratings obtained from tests carries out by manufacturer or those ordered by manufacturer from independent testing agency signifying performance capabilities, including “ As Manufactured (AM) “ tests in accordance with PWGCS MD 12128.

.5 Repeat AM test if required in presence of Departmental Representative.

1.8 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.1 Upon arrival and before installation, demonstrate that fume hood is consistent with prototype and product data, and has not been damaged in transit.
.2 Ensure fume hood bears CSA label.
Inspect fume hood and record condition using approved check sheet.
.3 Departmental Representative will supply check sheet.
.4 After check of fume hood inspection has been carried out have Departmental
.5 Representative sign sheet and submit sheet as part of record documentation.

.3 Storage and Handling Requirements:

.1 Store and protect fume hood, components and accessories from nicks, scratches, and blemishes.
.2 Replace defective or damaged materials with new.

1.9 WARRANTY

.1 Project Warranty: refer to Contract Conditions for project warranty provisions.

Part 2 Products

2.1 DESCRIPTION

.1 Laboratory fume hood: ventilated, enclosed work space, designed for continuous use to capture, confine and exhaust fumes, vapours and particulates generated with fume hood cavity.

.2 Factory fabricated package, piped and wired for single connections to exhaust system, electrical power, laboratory services, water supply, and laboratory drainage system.

.3 Fume hood base cabinets Included with all Fume Hoods.

2.2 DESIGN CRITERIA

.1 Fume hood, controls and alarms: ULC labeled.

.2 Fume hood face velocity: 0.50 m/s.

.1 Face velocity for high performance fume hoods: 0.35 m/s.
.2 Design sash position (normal operating sash height) at 450 mm.
.3 Noise level (with sash operating position) at 500 mm from sash: 70 dBA maximum.
.4 Average static pressure Loss: Not more than 93% (3/8 In. wg) at 0.51 m/s (100 FPM) face velocity when tested according to SFFA 12.

.3 Seismic: ensure fume hood manufacturer supplies anchor bolts and templates.

.1 Ensure anchor bolts are sized to withstand seismic zone acceleration and velocity requirements for location.
.2 Meet performance criteria in PWGSC MD15128.
.3 Construct to SEFA 1 Recommended Practices for Laboratory Fume Hoods.

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS

.1 Control exhaust air flow using sash position sensor located as per manufacturer's instructions and control specifications.

.2 Calibrate sash position sensor after field installation of fume hood.

.3 Ensure controls are integral with new laboratory HVAC supply, exhaust and pressurization control system.

.4 Use optional restricted Bypass Plate for VAV applications.

.5 For Detailed requirements refer to schedules at end of the section.

.1 Width: 1500 mm nominal.
.2 Height: 1500 mm nominal.
.3 Depth: 840 mm nominal.

.6 Sash: 6.4 mm thick minimum tempered safety glass to CAN/CGSB-12.1 in corrosion resistant PVC track with provisions for both raising and lowering sash.

.1 Sash handle: type 304 stainless steel #4 stainless steel with #45 satin finish, designed to eliminate eddies in plane of sash opening and thin enough in profile to minimize interference with line-of- fume hood user .
.2 Clear openable height to 700 mm.
.3 Protect user with heat resistant clear PVC film overlay bonded to exterior surface of sash.

.7 Sash opening: normal operating position to:

.1 Form part of fume hood design criteria.
.2 Ensure normal operating position is labeled on front
.3 Ensure opening is restricted by sash stop.
.4 Normal operating position of sash
    .1 Hood 450 mm opening above airfoil.

.8 Counterbalance mechanism: Use single counterweight, stainless steel multi-strand wires, 39mm minimum diameter nylon-tired ball-bearing pulley assembly, cable, cable retaining device, assembled to prevent creep or tilting of sash during operation.

.1 Sash to move easily and quietly with one finger operation, and remain inplace where it is stopped.
.2 Spring counterbalance mechanisms are not acceptable.
.3 Sash to open and close against rubber bumper stops, installed to ensure user can readily adjust sash opening when moving sash from either end.
.4 In event of failure of counterbalance mechanism, sash must remain 50 mm minimum above lowest part of airfoil.
.5 Sash guides; full length corrosion resistant extruded PVC tracks.

.9 Sash stop: include physical stop to prevent sash from opening beyond normal operating position under regular working conditions.

.1 Allow sash to open beyond normal operating position when placing apparatus in hood.
.2 Ensure sash automatically resets to normal operating limit.

.10 Sash for horizontal and combination sashes.

.1 Arrange horizontal sliding panels to ensure maximum opening area resulting from any orientation or configuration of sash panels does not exceed design opening area.

.11 Horizontal air-foil:

.1 1.9 mm type 316 stainless steel with #4 satin finish, installed 25 mm above raised portion of work surface and designed for eddy-free air entry.
.2 Project into fume hood beyond edge of sash.
.3 Design airfoil to eliminate reverse flow within 75 mm of plane of sash.

.12 Work surface: recess epoxy resin work surface 12 mm minimum to contain spills and include coved corners and raised edges. Construct to SEFA 3.

.1 Ensure joints with interior panels are sealed.
.2 Adhere 50 mm minimum line of yellow PVC tape to work surface 150 mm inside plane of sash for full width of work surface.

.13 Interior panels:

.1 Stainless steel: to ASTM A167 304with #4 satin finish with 12 mm minimum radius interior corners and welds ground smooth.
    .1 Flexural strength: 96.5 MPa.
    .2 Flame spread: 25 or less to UL 723 ASTM E84.

.2 Interior access panels: gasketted, removable and replaceable without use of special tools.

.14 Fastenings: ensure fastenings inside fume hood are corrosion resistant and remain unaffected by repeated manipulations.

.15 Baffles: construct baffles from same material as interior panels.

.1 Design baffles to provide multiple exhaust slots to minimize variations in face velocity across sash opening when sash is in normal operating position.

.2 Set baffles at manufacturer's plant on basis of prototype testing, and permanently mark setting

.16 Exhaust duct collar: 305 mm diameter, integral with top panel and constructed from stainless steel, with bell-mouthed entry, and flanged to accept exhaust duct.

.1 Exhaust duct collar size: to provide exhaust flow rate of 5.0 - 7.5 m/s minimum.

.17 Exterior panels:

.1 Cold rolled steel to ASTM A1008/A1008M finished with powder coating procedure, fastened using concealed stainless steel screws and devices.
.1 Ensure panels are easily removable to allow access to services.
.2 Do not use external screws.
.3 Include finished back panel for fume hood in middle of room.
.2 Finish: electrostatically applied urethane powder coat of selected colour and baked in controlled high temperature oven to assure a smooth, hard satin finish.
.1 Ensure surfaces have a chemical resistant, high-grade laboratory furniture quality finish with thicknesses as follow:
.1 Exterior surfaces exposed to view: 0.0375 mm average and 0.03 mm minimum.
.2 Backs of hood and other surfaces not exposed to view: 0.025 mm average.
.2 Colour selected from manufacturer's standard range by Departmental Representative.

.18 Superstructure: rigid self-supporting unit consisting of double wall construction with outer metal shell and inner lining of corrosion-resistant material.

.1 Panels must be attached to full frame construction, minimum 1.9 mm galvanized members.
.1 Attach panels and brackets to eliminate screw heads and metallic brackets from hood interior.
.2 Double wall to house and conceal steel framing members, attaching brackets and remote operating service fixture mechanisms, and complete with:
.1 Include levelling screws.

.19 Vertical side posts of fume hood face: radiused airfoil shape to reduce eddies and promote smooth entry of air into hood.

.1 Ensure service fixtures do not disturb air flow pattern.
.2 Incorporate removable panels to provide access to service valves as indicated
.3 Ensure unit is capable of accepting 5 maximum plumbing and laboratory services and one duplex electrical receptacle on each side of opening.
.4 Include light switch, monitor and alarm.

.20 Monitors and alarms:

.1 For each fume hood provide monitor with alarm capability
.2 Fume Hood DDC Monitors with operator Interface to be supplied and installed by Controls Contractor. The digital Operators Display Panel shall be mounted on the front of the Fume Hood. Coordinate installation of ODP with DDC laboratory control contractor. Reference Sections 23 30 04 and 23 44 00.

.3 Monitor to provide visual display showing average face velocity and provide visual and audible alarms configured to alert when flow or velocity varies more than 10% from design flow set point.
  .1 Monitor accuracy: 5% of measured parameter
  .2 Report readings and all alarms to Building Automation System (BAS
  .3 Include manual silencing switch for audible alarm only, designed to automatically reset to recommence monitoring function.
  .4 Ensure visual alarm remains lit until alarm condition has been rectified.
.4 Include test circuits, relays, switches, and other controls required to permit maintenance personnel to test signal function.
.5 Field set-up: minimum 3 point calibration.
.6 Analog output, 0-10 V, proportional to face velocity.
.7 Visual displays:
  .1 Display of velocity reading; resolution 0.01 m/s.
  .2 Green LED for safe operation.
  .3 Red LED for alarm or unsafe operation.

.21 Light fixture: CSA approved. T8 two-tube fluorescent, rapid start, with electronic sound-rated ballasts, mounted on exterior of fume hood roof with safety lens and approved sealant to isolate fixture from fume hood interior.

.1 Include flush-mounted switch in weatherproof box on side post of fume hood.
.2 Include lamps with fixtures.
.3 Interior illumination at work surface: 860 lux minimum.
.4 Accessible for maintenance from fume hood exterior.
.5 Sealant to be approved by Departmental Representative

.22 Factory wire electrical outlets and switches and terminate in box on roof of fume hood to CAN/CSA-C22.2 No.61010-1.

.1 Only ULC listed or CSA approved electrical devices are acceptable
.2 Provide switch for light.

2.4 LABORATORY SERVICES

.1 To SEFA 7.

.2 See Dwg H604 for schedule of connected services for all Fume Hoods.

.3 Remote controls:

.1 Brass body, universal joint, bolted and flanged with chromium plated finish to ASTM B456, service condition SC 4, coating classification CuNi30dCr.
.2 Gas: CGA approved.
.3 Install remote controls on vertical side posts of fume hood face, located to avoid interface with smooth entry into hood.
.4 Include needle valves on all services except gas services.
.5 Equip remote controls with Universal joints, wall flanges, coupling and tailpieces for connection to services.

.4 Outlets:

.1 Forged or cast brass body complete with tailpiece for connection to service piping.

.2 Turrets and handles to be of forged brass.
.3 Finish: inside fume hood grey vinyl corrosion-resistant fluorocarbon.

.5 Include grey vinyl corrosion-resistant finish for service outlets inside fume hoods.

.6 Electrical: 2 duplex receptacles 120 V, 20 amp, CSA approved, GFI, hospital grade, mounted in side posts, stainless steel cover plate.

.1 Connect electrical service to each fume hood to dedicated electrical circuit.

.7 Plumbing: include domestic hot and cold water service as indicated.

.1 Isolating valves: include remote controlled valves located within end panels, controlled by handles projecting through side posts of fume hood.
.2 Locate to avoid interference with smooth entry of air into fume hood.

.8 Fixtures: except for de-ionized, RO and pure water, fixtures exposed within fume hood to have chemical-resistant metallic bronze finish.

.1 Ensure portions exposed to fume hood exterior are chrome plated.

.9 Cup sinks: 75 x 150 mm oval (or nearest standard), rigidly clamped in approved manner to work surface, with approved acid-resisting seal, 38 mm drain with cross strainer debris catcher.

.1 Standing waste and overflow with 76 long minimum PVC tailpiece.
.1 Install with rim above work surface to prevent spills entering waste system.
.2 Finish welds smooth and polished.
.2 Hot and cold water faucets: deck mounted with rigid gooseneck of heavy duty 10 mm brass pipe with integral backflow preventer upstream from serrated nozzle and remote control on exterior panel.

.10 Vacuum outlet:

.1 Aspirating type, with single straight serrated nozzle outlet with flange, mounted on side panel inside fume hood, separate water service, outlet discharging into cup sink.

.11 Gas: single straight serrated nozzle outlet with flange, mounted on side panel fume hood.

.1 Remote control on exterior panel.

.12 Compressed air: single straight serrated nozzle, outlet with flange, mounted on side panel inside fume hood.

.1 Other service outlets: as scheduled.

.13 De-ionize, RO and pure water faucets: polyvinyl with corrosion resistant finish, polyoxymethylene lining and stainless steel valves.

.1 Align faucets with cup sink to prevent overspray and wetting of fume hood interior surfaces.

.14 Identify service fixtures using colour coding as follows:

Services	Letter Coding	Colour Coding
Cold water	CW	Green
Hot water	HW	Red
Distilled	DIH	White
De-ionized water	DEW	White
RO water	ROW	White
Pure water	PW	White
Vacuum	VAC	Yellow
Compressed air	AIR	Orange
Propane	PRO	Yellow-Orange
Natural gas	NG	Yellow-Orange
Oxygen	OXY	Green
Nitrogen	N	Blue
Argon	A	White
Steam	ST	Black

.15 Access to services:

.1 Ensure fume hood manufacturer includes 5 cut-outs per side post.
.2 Cap unused openings with cap plugs of same material as exterior panels.
.3 Ensure service connections are accessible from fume hood exterior through removable access panels.
.4 Include isolating valves on building side of services.
.5 Where two or more fume hoods are installed side by side, use interior access panels of same material as interior panels, with beveled edges, moulded PVC gaskets, and secured with non-corrosive fasteners set flush with face of access panel.

.16 Corrosion resistant label:

.1 Provide corrosion-resistant label permanently attached to fume hood exterior with abbreviated information relating to sash position and recommended location of apparatus and accessories when place within the fume hood.

.17 Base furniture:

.1 Construct base furniture in accordance with Section 12 35 53.13 – Steel Laboratory Casework and Section 23 38 16.13, 2.6, below.

2.5 HIGH PERFORMANCE FUME HOODS

.1 Meet requirements for CAV bypass fume hoods, except for specific tests associated with reduced face velocity.

2.6 FLAMMABLE AND COMBUSTIBLE LIQUID STORAGE CABINET

.1 Cabinet to meet requirements of NFPA 30 and ULC approved.

.2 Cabinet to be provided with grounding wire connections

.3 Cabinet to be constructed of 18 gauge steel, double wall construction, with 50 mm thick fire proof insulating metal sandwiched between inner and outer walls.

.4 Door sill to be raised 50 mm above bottom of cabinet to form liquid tight joint.

.5 Cabinet to be supplied with four (4) adjustable levelling feet.

.6 Cabinet to be double door style with three (3) point lock on door.

.7 Cabinet to be provided with NPS 2 threaded vents one on each side at top and bottom of cabinet to enable continuous cabinet ventilation. Each vent to be internally with fire baffle.

.8 Cabinet to be supplied complete with adjustable satin coat galvanized shelves to permit storing of various sizes of containers.

.9 Cabinet to be painted with yellow safety enamel with red letters, warning “FLAMMABLE –KEEP FIRE AWAY” in English and French.

.10 Cabinet to be individually cartooned.

.11 Cabinet and dimensions: as indicated.

2.7 FABRICATION

.1 Do welding to CSA W48.

2.8 ACCESSORIES

.1 Heat shields: install where required to protect interior panels from radiant heat.

  .1 Ensure shields are easily removable for cleaning and do not compromise safe operation of fume hood.

2.9 SOURCE QUALITY CONTROL

.1 “As Manufactured” Testing Equipment: to PWGSC MD15128.

  .1 Data logger:
    .1 Recording interval: 10 Hz or better.
    .2 Memory: sufficient to allow data collection for duration of test.
  .2 In-duct flow sensor to measure flow response:
    .1 Speed: 10 Hz.
    .2 Range: 95 L/a to 950 L/s.
    .3 Accuracy: 5%.

.3 Thermal anemometer:
 .1 Mounting: on stand with probe fixed at each traverse grid location.
 .2 Include: output recorder for 20 seconds minimum at a rate of 1 reading/second on data logger.
 .3 Accuracy:
  .1 Below 0.50 m/s: 0.025 m/s
  .2 0.50 m/s and over: 5%.
.4 Detector for tracer gas containment:
 .1 Type: continuous reading.
 .2 Minimum Detectable Level (MDL): 0.01 ppm.
 .3 Accuracy:
  .1 Concentrations below 0.01 ppm: 25%
  .2 Concentrations above 0.01ppm: 10%
.5 Smoke Generator:
 .1 Use smoke generator and diffuser complying with PWGSC MD15128.

.2 Conduct "as manufactured: (AM) tests in manufacture's testing facility to ANSI/ASHRAE 110 procedures before transportation to site.

.3 Ensure tests achieve performance criteria on accordance with PWGSC MD15128.

 .1 Issuance of purchase order will be made only by Departmental Representative ad Departmental Representative has received and approved in writing factory performance test report certifying test results.

.4 Co-ordinate with controls manufacturer for transportation of all relevant control to fume hood manufacturer for installation and calibration to function as specified. Controls to include, but not limited to:

 .1 Fume hood monitor/alarm (ODP). (See Section 25 30 04)
 .2 Sash position sensor.

.5 Conduct "AM" test as follows:

 .1 With fume hood empty.
 .2 With fume hood loaded to simulate apparatus in hood.
  .1 Locate simulated apparatus 150-250 mm behind plane of sash in manner approved by Departmental Representative as follows:
   .1 1 - 3.8 litre paint cans.
   .2 1 – 300 x 300 x 450 mm cardboard box.
   .3 4 – 150 x 150 x 300 mm cardboard boxes.
 .3 With simulated cross drafts:
  .1 Challenge with 0.25 m/s using 620 mm recirculation fan under conditions as follows:
   .1 Air directed horizontally at 45 degrees to plane of sash.

.6 Witnessing "AM" Tests:

 .1 Perform "AM" : tests in presence of Departmental Representative.
 .2 Notify Departmental Representative 2 weeks minimum before start of testing.

.7 Conduct "As Manufactured" (AM) Fume Hood Performance Tests as follows:

 .1 Visualization (smoke) tests: Meet or exceed performance criteria of PWGSC MD15128.

.2 Face velocity and flow tests: to PWGSC MD15128.
  .1 Average face velocity: 0.5 m/s with variations allowed for individual readings; maximum 20%.
  .2 CAV bypass effectiveness at 150mm sash opening: 1.25 m/s maximum average face velocity.
  .3 VAV average face velocity with sash at 66% of design position: 0.5 m/s 0.025 m/s.
    .1 Variation allowed for individual reading: 20 %
  .4 VAV response time: time to reach 90% of the steady state value: within 3 seconds.
  .5 Test for VAVA minimum flow sash closed to: ANSI/AIHA Z9.5 capable of maintaining 375 air changes per hour.
.3 Tracer gas test: to PWGSC MD15128.
  .1 Conduct tests at target average face velocity.
  .2 Use approved tracer gas.
  .3 Perform tests with probes at heights of 560 mm above work surface.
  .4 Leakage with sash at normal operating positions:
    .1 Average leakage: 0.025 ppm maximum.
    .2 Peak reading: 0.100 ppm.
  .5 Leakage with sash in fully open position:
    .1 Average leakage: 0.05 ppm maximum.
    .2 Peak reading: 0.25 ppm.
  .6 Peripheral scan:
    .1 Record significant peak readings and their locations.
    .2 Record 30 seconds rolling averages.
    .3 Maximum 0.25 ppm for any 30 seconds rolling average.
    .4 Include readings in test report.
  .7 Sash movement effect (SME), to determine potential for escape after movement of sash to ANSI/ASHAE 110 procedures.
    .1 Maximum 45 second rolling average: 0.05 ppm.
  .8 Conduct VAV response tests, stability tests and SME simultaneously for VAV fume hoods.

2.10 PRODUCT SUBSTITUTIONS

.1 Substitutions: in accordance with DN01.

.2 Ensure components come from one manufacturer.

  .1 Acceptable Manufacturers:
    .1 Mott, Labconco, Bedco Lab, Waldner.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions; verify conditions of substrate previously installed under other Sections of Contracts are acceptable for fume hood installation in accordance with manufacturer’s written instructions.

  .2 Visually inspect substrate in presence of Departmental Representative.

.3 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

.1 Replace existing Fume Hoods with new as indicated on the drawings. Disconnect existing services and reconnect services to new Fume Hoods as per schedule on drawing H505.

.2 Install to SEFA 2.

.3 Install plumb, with work surface level to within 1.5 mm in 3000 mm by adjusting base unit leveling screws.

.4 Secure fume hood to base furniture using stainless steel fasteners spaced at 750 mm maximum on centre maximum, 3 minimum per side.

  .1 Use 4 minimum for each fume hood.

.5 Secure fume hood to meet seismic criteria.

.6 Connect plumbing, laboratory services, electrical services, exhaust system, and BAS to fume hood.

3.3 FUME HOOD SYSTEM INTEGRATION – GENERAL REQUIREMENTS

.1 General requirements: fully integrate fume hood exhaust systems into laboratory HVAC system and into BAS in order to maintain specified pressurization requirements and to maintain fume hood performance.

  .1 Minimum air flow with sash closed: to ANSI/AIHA Z9.5.
  .2 Ensure heater controls are integrated into fume hood control system.

.2 Operating Modes:

  .1 Occupied – in use: generation of hazardous products occurring.
  .2 Occupied – not in use: as when apparatus is being assembled.
  .3 Unoccupied – in use: generation of hazardous products occurring while fume hood is unattended. Sash is closed.
  .4 Standby: fume hood not in use: no active generation of hazardous products, minimum air flow. Sash closed.

.3 Fume Hood System Integration with Dedicated Exhaust Fan:

  .1 No local control of exhaust fan permitted.
  .2 Ensure exhaust fan does not be shut down except when fume hood is decommissioned, for apparatus assembly of for service procedures.

.4 Monitor:

  .1 Green light to indicate: power on” and “safe to operate”.
  .2 Audible and visual alarms: horn, buzzer or bell and red light to indicate air velocity out of range and “not safe to operate”.
    .1 Use fume hood only when safety controls are satisfied.

.2 Override audible alarm using silencing relay switch (red light to remain on) until abnormal condition is rectified.
.3 Reset alarm system automatically when safe conditions restored.
.3 Ensure complete operating instructions for alarm system are secured to fume hood.
.4 Interlock fume hood exhaust system with HVAC system.
.1 Ensure fume hood exhaust fan continues to run upon activation of building fire alarm system.

.5 Fume Hood System Integration with Manifolded Fume Hood Exhaust System:

.1 No local control of exhaust fans permitted.
.2 Monitor.
.1 Green light to indicate “power on” and “safe to operate” .
.3 Audible and visual alarms: horn, buzzer or bell and red light to indicate air velocity out of range and “not safe to operate”.
.1 Use fume hood only when safety controls are satisfied.
.2 Override audible alarm using silencing relay switch (red light to remain on) until abnormal condition is rectified.
.3 Reset alarm system automatically when safe conditions restored.
.4 Ensure complete operating instructions for alarm system are secured to fume hood.
.5 Interlock fume hood exhaust system with HVAC system.
.1 Ensure fume hood exhaust system continues to run upon activation of building fire alarm system.

.6 Connect 1 manifolded fume hood exhaust fan emergency power.

3.4 ADJUSTING

.1 Adjust operable hardware for correct function.

.2 Ensure sash does not bind while opening and closing.

3.5 FIELD QUALITY CONTROL

.1 Field tests:

.1 Conduct integrated : as installed” (AI) tests in accordance with Section 23 05 93.13 – Testing, Adjusting and Balancing of Fume Hoods.

.2 Field Inspection: co-ordinate field inspection in accordance with Section 01 45 00 – Quality Control.

.3 Manufacturer’s Services.

.1 Co-ordinate manufacturer’s service with Section 01 45 00 – Quality Control.
.1 Have manufacturer review work involved in handling, installation, protection, and cleaning of fume hood components and accessories, and submit written reports in acceptable format to verify compliance of Work with Contract conditions.
.2 Manufacturer’s Field Services: include manufacturer’s field services consisting of product recommendations and Two (2) site visits for product installation review in accordance with manufacturer’s instructions.

.1 Report inconsistencies from manufacturer's recommendations immediately to Departmental Representative.

.3 Schedule site visits to review work stages listed.
.1 Once during progress of work at 25% complete.
.2 Upon completion of Work, after cleaning is carried out.
.3 Obtain reports within three days of review and submit immediately to Departmental Representative.

3.6 COMMISSIONING TESTS FOR INTEGRATED FUME HOOD SYSTEMS

.1 Do commissioning tests in accordance with Section 01 91 13 – General Commissioning (CX) Requirements.

.2 Test fume hoods in conjunction with complete laboratory integrated – HVAC and exhaust systems commissioning testing including, room air flow patterns, temperature, humidity, pressurization, noise, and vibration.

3.7 PROTECTION

.1 Protect installed fume hood components from damage during construction.

.2 Repair damage to adjacent materials caused by fume hood installation.

3.8 FUME HOOD SCHEDUELS

.1 See Dwg. H604 for schedule of connected services.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

.1 A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood at an occupied or unoccupied mode. The laboratory control system shall vary the amount of makeup/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The laboratory airflow control system shall be capable of operating as a standalone system.

1.2 REFERENCE STANDARDS

.1 American Conference of Governmental Industrial Hygienists (ACGIH). Industrial Ventilation, A Manual of Recommended Practice. 22nd ed.

.2 ANSI/AIHA Z9.5 National Standard for Laboratory Ventilation.

.3 American Society of Heating, Refrigerating and Air Conditioning Departmental Representatives Inc. (ASHRAE). 1995 ASHRAE Handbook.

.4 CRC Handbook of Laboratory Safety, 4th ED.

.5 National Institute of Health. NIH Design Policy and Guidelines.

.6 National Fire Protection Association (NFPA). NFPA 45 Fire Protection for Laboratories Using Chemicals 1996 Edition.

.7 Underwriters Laboratories Inc. UL 913, Standard for Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, II and III, Division 1, Hazardous (Classified) Locations, 4th ed., July 29, 1988. Northbrook, Illinios: Underwriters Laboratories Inc., 1988.

.8 ASHRAE Standard 110 - Method for Testing Performance of Laboratory Fume Hoods.

.9 PWGSC Standard MD15128-2013, "Laboratory Fume Hood Guidelines.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 –Shop Drawings and Other Submittal Procedures.

.2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

.3 The laboratory airflow control system supplier shall provide a detailed proposal describing all elements of the laboratory control system. A schematic laboratory layout shall be provided, showing relations of these elements and a description of how they interact.

.4 Technical specification data sheets shall be provided for all proposed system components and devices.

.5 All proposed airflow control devices shall include discharge, exhaust, and radiated sound power level performance obtained from testing in accordance with ARI Standard 880.

1.4 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 ACCEPTABLE MATERIALS

.1 System is based on Venturi Style supply and exhaust air valves. Blade dampers will be acceptable.

.2 In addition to air flow measurement, air flow measurement based on Actuator arm travel shall also be provided. It shall be within + 2 ½ % of measured airflow.

.3 The system shall be able to interface with the existing Native BACNET Delta Control System on site.

.4 Actuators shall be electronic or digital where shown.

.5 Warranty and scheduled maintenance agreement, as described in paragraph 1.6 and 1.7 shall be met.

1.6 PREVENTIVE MAINTENANCE

.1 The laboratory airflow control system supplier shall provide for one year of required preventive maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.), and flow transducers provided under this section.

.2 Airflow sensors shall be removed, inspected, and cleaned prior to or at the 10 month warranty inspection during the one year period to prevent inaccuracies due to long term buildup from corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor.

.3 If impractical to remove the airflow sensors, the laboratory airflow control system supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor.

.4 The transducer shall be checked and recalibrated annually to insure long term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

1.7 WARRANTY PERIOD

.1 Vendor shall provide full parts and labour warranty for a period of 12 months from date of substantial completion of Project.

1.8 SPARE PARTS

.1 Laboratory Ventilation Controls Contractor (LVC) shall supply one (1) spare air valve of each size used on the project to the Departmental Representative.

.2 Laboratory Ventilation Controls Contractor (LVC) shall supply fume hood controls for all fume hoods indicated on the drawings. Twenty-one (21) fume hoods and controls will be installed in this contract.

Part 2 Products

2.1 AIRFLOW CONTROL SYSTEM

.1 Each individual laboratory module shall have a dedicated laboratory airflow control system.

.2 The laboratory airflow control system shall employ individual average face velocity controllers that control the hood’s exhaust flow to maintain a constant face velocity of 18m/min (60 fpm) or 30m/min (100 fpm) depending on an occupied/unoccupied schedule.

.3 The lab air flow control system shall use sash position sensors to vary the F.H. exhaust flow to maintain 30m/min face velocity at all sash position.

.4 The laboratory airflow control system shall maintain specific airflow +/- 5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change (within 150 Pa to 750 Pa wc), airflow change or quantity of airflow control devices on the manifold.

.5 The laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure.

.6 The laboratory airflow control system shall maintain specific airflow +/- 5% of signal) with a minimum 5 to 1 turndown to insure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.

2.2 AIRFLOW CONTROL SOUND SPECIFICATION

.1 Unless otherwise specified, the airflow control device shall not exceed the sound power levels in Table 1, Table 2 and Table 3.

.2 If the airflow control device cannot meet the sound power level specification, a properly sized silencer or sound attenuator must be used. All silencers must be of a packless design (constructed of at least 18 gauge 316L stainless steel when used with fume hood exhaust) with a maximum pressure drop at the device's maximum rated flow rate not to exceed 50 Pa of water.

.3 All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance.

.4 All general exhaust valves ducted to grilles or canopy hoods shall utilize optional sound neutralizers. These shall reduce the device's sound levels at 566 l/s and 747 Pa by 3, 3, 2, 10; 9 and 7 db for 125, 250, 500, 1000, 2000 and 4000 Hz centre frequency bands respectively.

Table 1 - Exhaust Airflow Control Device Sound Power Level

	Exhaust Sound Power Level in dB (re: 10-12 watts)					
Octave Band Number	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1000-50 cfm Device						
800 cfm @ 0.6" wc	63	55	52	54	50	49
200 cfm @ 0.6" wc	46	42	38	37	32	25
800 cfm @ 3.0" wc	73	70	64	66	65	60
200 cfm @ 3.0" wc	51	52	51	50	52	51
1500-100 cfm Device						
1200 cfm @ 0.6" wc	65	58	53	56	52	52
400 cfm @ 0.6" wc	50	45	38	39	37	31
1200 cfm @ 3.0" wc	72	70	62	65	64	60
400 cfm @ 3.0" wc	55	57	55	53	56	55

Table 2 - Supply Airflow Control Device Sound Power Level (Discharge)

	Discharge Sound Power Level in dB (re: 10-12 watts)					
Octave Band Number	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1000-50 cfm Device						
800 cfm @ 0.6" wc	62	57	54	58	54	51
200 cfm @ 0.6" wc	45	46	42	44	40	34
800 cfm @ 3.0" wc	72	71	67	75	72	68
200 cfm @ 3.0" wc	53	56	54	58	56	54

	Discharge Sound Power Level in dB (re: 10-12 watts)					
1500-100 cfm Device						
1200 cfm @ 0.6" wc	63	59	55	60	54	53
400 cfm @ 0.6" wc	53	49	44	49	45	39
1200 cfm @ 3.0" wc	72	73	69	77	72	68
400 cfm @ 3.0" wc	58	63	61	63	60	57

Table 3 - Supply Airflow Control Device Sound Power Level (Radiated)

	Radiated Sound Power Level in dB (re: 10-^{12})					
Octave Band Number	2	3	4	5	6	7
Centre Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1000-50 cfm device						
800 cfm @ 0.6" wc	44	41	45	41	36	34
200 cfm @ 0.6" wc	33	28	31	29	26	20
800 cfm @ 3.0" wc	53	53	56	57	55	53
200 cfm @ 3.0" wc	41	38	41	39	39	37
1500-100 cfm Device						
1200 cfm @ 0.6" wc	47	53	40	42	38	36
400 cfm @ 0.6" wc	35	39	31	34	33	26
1200 cfm @ 3.0" wc	52	60	54	60	59	53
400 cfm @ 3.0" Wc	42	44	43	46	46	42

2.3 AIRFLOW CONTROL DEVICE - GENERAL

.1 The airflow control device shall be a Venturi valve or damper blade.

.2 The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.

.3 The airflow control device shall maintain accuracy within +/- 5% of signal over an airflow turndown range of no less than 5 to 1. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.

.4 The airflow control device shall be constructed of one of the following Two (2) types:

Class A - The airflow control device for supply shall be constructed of 16 gauge aluminium or 20 ga. galvanized steel. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, or polyester, or PPS (polyphenylene sulfide) composite.

All supply air devices will be configured as Dual-Duct mixing boxes with separate hot deck and cold duct connections. A conventional ultra quiet Dual-Duct (Dual Damper) VAV box may be used, or two (2) air valves may be configured in lieu of a Dual-Duct Box.

Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.

Class B - The airflow control device for corrosive airstreams such as fume hoods and biosafety cabinets shall have a baked-on corrosion resistant phenolic coating or be constructed of 316 stainless steel. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of a Teflon or PPS (polyphenylene sulfide) composite.

.5 For two-position, a DDC actuator shall be factory mounted to the valve. Loss of control power shall cause normally open valves to fail to maximum position, and normally closed valves to fail to minimum position. Electric actuators that fail in last position are not acceptable. (2 position applies only to canopy exhaust and dampers (EC).

.6 Certification
- .1 Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least +/- 1% of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to +/- 5% of signal at a minimum of eight different airflows across the full operating range of the device.
- .2 All airflow control devices shall be individually marked with device specific, factory calibration data. As a minimum, it should include: tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.

2.4 OFFICE AIR FLOW DEVICE

.1 The office airflow device shall maintain a temperature setpoint by controlling the airflow of the Dual-Duct Mixing Box hot deck and cold deck in sequence in response to the room temperature sensor.

.2 The office airflow devices shall have the response and failsafe conditions of the laboratory airflow devices.

2.5 TWO-POSITION EXHAUST AIRFLOW CONTROL DEVICE

.1 The airflow control device shall maintain a factory calibrated fixed maximum and minimum flow setpoint based on a switched electronic signal. Two-position devices requiring feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow.(2-Position Conrol only applies to exhaust canopies (EC).

Part 3 Execution

3.1 INSTALLATION

.1 The Laboratory Ventilation Controls (LVC) contractor shall install the interface boxes, presence and motion sensor, and fume hood monitor on the fume hoods. Sash position sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted in an accessible location.

.2 The LVC shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.

.3 All cable shall be furnished and installed by the LVC contractor. The LVC contractor shall terminate and connect all cables as required.

.5 The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.

.6 The mechanical contractor shall provide and install all new dual-duct VAV boxes and associated ductwork and transitions as per Section 23 31 13.

.7 The mechanical contractor shall provide and install insulation as required.

.8 Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

.9 The LVC shall supply all the controls for the fume hoods as indicated on the drawings. Twenty (20) fume hoods will be installed and controlled under this contract.

3.2 SYSTEM START-UP AND TRAINING

.1 System start-up shall be provided by a factory authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return).

.2 The balancing contractor shall be responsible for final verification and reporting of all airflows.

.3 The laboratory airflow control system supplier shall furnish a minimum of forty hours of Departmental Representative training with certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.

.4 Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided for each training attendee.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This General Requirements Section applies to following technical sections:
- .1 The "provide" in this Section shall be interpreted as "supply & install".
- .2 Use material and equipment available from in regular production by approved manufacturer.
- .3 All equipment and material to be new, CSA certified, manufactured to minimum standard quoted including additional specified requirements.
- .4 Use material and equipment available from a regular production by manufacturer concerned.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)
- .1 ANSI/ISA S5.5-1985, Graphic Symbols for Process Displays.
- .2 ANSI/IEEE 260.1-1993, Letter Symbols for SI and Certain Other Units of Measurements SI Units, Customary Inch-Pound Units and Certain Other Units).

.2 Canadian Standards Association (CSA)
- .1 CAN/CSA-C22.2No.0-M91 (R2001), General Requirements, Canadian Electrical Code, Part II.
- .2 CAN/CSA-Z234.1-00, Canadian Metric Practice Guide.

.3 Electrical and Electronic Manufacturers Association (EEMAC).
- .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.4 American Society of Heating Refrigerating and Air-Conditioning Departmental Representatives.
- .1 ASHRAE 135-2001.

1.3 GENERAL REQUIREMENTS

.1 The Energy Monitoring and Control System (EMCS) shall be configured as a high speed peer-to-peer network of DDC controllers and operator work stations (OWS) residing and communicating on a BACNET IP network satisfying the following general requirements:
- .1 The Operator Work Station consists of Operator interface, terminal devices, and provides for operator interaction and dynamic process manipulations as well as overall system supervision, coordination, control, data and program storage, and reporting capabilities.
- .2 Sensed data shall be obtained from Programmable Controllers consisting of MCU's, LCU's, AND TCU's which are located within their particular data environments, and control all aspects of their connected points.
- .3 Refer to control schematics for system architecture.
- .4 The control system shall be supplied with a complete web enabled package. The system shall support unlimited users using standard web browsers such as Internet Explorer and Netscape. The web server software shall operate on standard industry PC servers. Web browser software shall be manufactured by the control system manufacturer and shall have the same look and feel as the operating system.

.2 The work in general covered by this specification and related sections consists of following:

.1 The preparation of submittal and provision of all related services.

.2 Furnish and install Controllers including Master Control Units (MCU), Local Control Units (LCU) , Terminal Control Units (TCU), sensors and all control devices as listed in Input Output Summaries.

.3 Operator Work Stations located as shown on drawings or listed in the specifications.

.4 The contractor shall maintain is his office a monitoring system complete with alarm printer and graphic display connected to the system through a web browser software. The monitoring shall remain in place until the end of the service contract.

.5 Furnish all field equipment including sensors, transducers, valves, dampers, damper operators, flow measuring stations, and static pressure measuring stations as specified.

.6 Furnish and load all software required to implement a complete and operational EMCS system.

.7 Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.

.8 Perform acceptance tests and technical support during commissioning as indicated.

.9 Provide full documentation for all software and equipment.

.10 Miscellaneous work as indicated in these specifications and the contract drawings (including wiring interface coordination of equipment supplied by others).

.11 Furnish a complete native BACNET control system including a Microsoft Windows based distributed logic control system. BACNET means all level of controls are to be BACNET based such as Global Controllers (Router), Logic Controllers (Unitary) and all input/output devices. All direct digital logic hardware to be in compliance with ASHRAE Standard 135-2001.

.3 The Operators Work Station (OWS) for this project will be located in the Boiler Plant Control Room, communicating via the bldg. Ethernet. The new OWS shall be capable of incorporating the existing DDC Controls OWS software and programming so the operator can run both systems from a single workstation using Windows Multi-tasking features. The OWS will be provided by the Departmental Representative, but software programming and setup will be by controls contractor. If the Two (2) controls systems cannot operate on the same OWS, the contactor must provide a separate OWS.

1.5 ABBREVIATIONS AND SYMBOLS

.1 Symbols and Abbreviations: Letter symbols and Departmental Representativeing unit and Symbols abbreviations utilized to conform to ANSI Y10.19./IEEE 260.

1.6 SYSTEM DESIGN AND RESPONSIBILITY

.1 The drawings do not show conduit size or wire type to link the various elements of the system. The EMCS Contractor is responsible for designing these links. Allow for future expansion capabilities.

.2 Provide sufficient Programmable Controllers of all types to meet the intent of the specification. Departmental Representative to approve the quantity and point content of the MCU'S prior to installation.

.3 Obtain Departmental Representatives approval of controllers locations prior to installation.

.4 Provide power to the controllers.

1.7 ELECTRICAL WORK AND SAFETY REQUIEMENTS

.1 Electrical work shall be in accordance with NFPA 70 and ANSI C2 and requirements of Division 26. Electrical wiring, terminal blocks contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.

.3 Division 25 shall supply relays for controlling the cabinet and unit heaters for installation by Division 26.

1.8 MANUFACTURER'S RECOMMENDATIONS

.1 Printed copies of manufacturer installation procedures and recommendations are to be included with shop drawing submission. Installation of the items will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations shall be cause for rejection of the material.

1.9 LOCKABLE PANELS

.1 All panels shall be EEMAC rated to environment requirements with hinged doors and equipped with standard keyed-alike cabinet locks.

1.10 IDENTIFICATION AND NAMEPLATE

.1 Nameplates shall be provided for all control items listed or shown approved control diagrams. Each inscription shall identify its function, such as "mixed air output transducer", "cold deck sensor".

.2 All panels and items mounted on panel faces shall be identified by laminated plastic nameplates 3 mm thick Melamine plastic white with black centre core. Surface shall be a matte finish. All corners shall be square. The lettering shall be accurately aligned and engraved into the white core. Size of nameplates shall be 25mm by 67mm minimum. Lettering shall be minimum 7mm high normal black lettering.

.3 Field Sensors, Controlled Devices, and Interior Panel Components shall be identified by 5 cm x 10 cm plastic enclosed cards attached to the device by chain. Data to include point name, schematic drawing designation number, model number, capillary length, size, range, set point & other pertinent data. Print shall be 5mm high and produced from a laser printer in dark black.

.4 Room sensing elements are to be similarly and identified by stick on labels on the inside cover. The point name shall be displayed on the face of the cover by engraved or laminated nameplates.

.5 Submit samples of identification tags and lists of wording proposed for approval.

.6 All Controller and companion cabinet interior components must be labelled.

.7 Warning signage: Each motor starter under remote automatic control (DO point on I/O Summary Sheet) shall be provided with orange coloured signage warning of automatic starting under control of EMCS (i.e." Caution - this equipment is under automatic remote control of EMCS). This signage to be provided by Division 25 Contractor.

1.11 WIRING IDENTIFICATION

.1 Provide numbered tape markings on all branch control wiring.

.2 Colour coding of wiring to CSA C22.1-1997 Section 4-034.

.3 At all junction boxes, splitter, cabinets and outlet boxes, maintain identification system.

.4 Use colour coded wires in communication cables, matched throughout system.

.5 Identify all power sources at each panel location.

1.12 CONDUIT IDENTIFICATION

.1 Colour code all EMCS conduits.

.2 Coding to be located on all conduits and cables exposed after completion of construction in all locations including suspended removable ceilings, tunnels and shafts.

.3 Coding to be plastic tape or paint at all points where conduit or cable enters wall, ceiling, or floor, and at 15000mm intervals.

.4 Coding to be 25mm wide, and fluorescent orange. Colour to be confirmed by the Contractor with Departmental Representative at commencement of the project.

1.13 MANUFACTURER'S AND CSA LABELS

.1 Manufacturers' nameplates and CSA labels to be visible and legible after equipment is installed.

1.14 DESIGN REVIEW

.1 Contractor shall submit design data in the specified stages and sequence consisting of preliminary design documents, shop drawings including manufacturer's data, and software. Provide three hard copies of all printed material and one soft copy on USB in latest Autocad format and PDF of all drawings and equipment schedules. Structure soft copy material and operator's instructions with a menu format for easy loading and retrieval.

.2 Preliminary Design Review:

  .1 Within 20 working days after award of the contract submit a preliminary design document for review by the Departmental Representative. Submission document shall be bound in a 210 X 275mm three ring binder, indexed, complete with section index and cross referenced with specification paragraph numbers. This document shall contain the following information:

.1 Contractor Information:
  .1 Location of local office.
  .2 Description & location of technical staff available for installation and service.
  .3 Location & qualification of programming design and programming support staff.
  .4 Location of spare parts stock, and list of spares if necessary.
  .5 Name of Project Manager.
  .6 Names of all sub- Contractors and key personnel site specific.
.2 System Information:
  .1 Sketch of site specific system architecture showing equipment and field Controllers, Specification sheets for each item above including memory provided, programming language, speed and type of data transmissions
  .2 Descriptive brochures of the proposed system.
  .3 Sample CDL and graphic presentation.
  .4 Response time for each type of command and report.
  .5 Documentation that the system meets BAC net.
  .6 An indexed item by item statement of compliance with the specification indicating Contractor's method of meeting requirements.
  .7 Lay out of equipment in control centre.
  .8 Automatic features provided.
  .9 Description of the requirements for changing set points, limits, start time, etc.
  .10 System capacity and limits of expansion.
  .11 Type and size of memory with statement of spare capacity.
  .12 Description of software programs included.
  .13 An indication of additional information required in order to provide a complete working system.
  .14 Samples of displays, reports, logs and samples of operator instruction manual.
  .15 Outline of proposed testing and acceptance and training procedures.

1.15 PRELIMINARY SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 33 00 and as specified herein.

.2 Within 30 working days of preliminary design review approval provide preliminary shop drawings to enable proper selection of equipment and ordering of long lead time items including:
  .1 Specification sheets for each piece of equipment used cross referenced with the specification section and paragraph numbers.
  .2 Manufacturers' descriptive literature, equipment specification, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts including the manufacturers' name, trade name, catalog model or number, nameplate data, size, lay out dimension, capacity, specification reference, applicable specification references, and all other information necessary to establish contract compliance.

.3 Detailed system architecture showing all points associated with a Controller.
.4 Show spare point capacity by number and type for each Controller.
.5 Controller locations
.6 Auxiliary control cabinet locations
.7 Single line diagrams showing cable routings, conduit size and spare capacity between control centre, field controllers & major mechanical systems.
.8 Complete valve schedule listing including following information:
  .1 designation
  .2 service
  .3 unit model
  .4 point I.D.
  .5 design flow
  .6 pressure drop
  .7 required CV
  .8 valve size
  .9 actual CV
.9 Damper sketches for each damper showing module assembly, interconnecting hardware, operator locations. Also, provide spring range, pilot range, required torque and actual torque.
.10 Flow measuring stations to include following information:
  .1 designation
  .2 service
  .3 point I.D.
  .4 model
  .5 size
  .6 velocity (100%)
  .7 velocity transmitter
  .8 range

1.16 PRELIMINARY DEISGN REVIEW MEETINGS

.1 The Contractor shall convene a design review meeting within 45 working days of contract award to review the following:
  .1 Functional review of the preliminary design documents to resolve inconsistencies.

.2 Resolution of conflicts between contractual document information and actual items (e.g. point list inconsistencies)

.3 Interface requirements of material supplied by others.

.4 Review of sequence of operations to ensure an agreement as to intent between the Departmental Representative and the contractor's programmer. Contractor's programmer to attend meetings. Departmental Representative retains right to revise any sequence or subsequent CDL to his satisfaction at any time prior to software finalization without cost to the Departmental Representative.

1.17 FINAL SHOP DRAWINGS

.1 Within 60 days after award of contract and before start of construction, provide shop drawings consisting of:
   .1 Updated correction to previous shop drawings.

.2 Wiring and piping diagrams, interface wiring diagrams complete with termination connections for equipment supplied by others. Indicate signal levels.

.3 Shop drawing for each input/output device, showing all information associated with each particular point including:
   .1 Sensing element type and location.
   .2 Transmitter type and range.
   .3 Details of associated field wiring schematics, schedules and terminations.
   .4 Point address.
   .5 Setpoints or curves or graphs and alarm limits (H + L, 3 types) and signal range.
   .6 Manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.

.4 Control schematics with Narrative Description and Control Description Logic fully showing and describing operation and/or manual procedures available to achieve proper operation of the building, including under complete failure of the EMCS.

.5 Graphic displays of all major air and water systems and typical building floor plans or as specified. Displays to include point labels and textual description of system.

.6 Complete system CDL's including companion English language explanations on the same sheet (use different fonts and italics). CDL's must contain the energy optimization programs specified elsewhere.

.7 A listing and example of all reports.

.8 A listing of all time schedules.

.9 A detailed to-scale drawing of the control room showing location of all equipment and operator work space.

1.18 TESTING

.1 Test and verify all major subsystems of the complete EMCS including all field components and an onsite field operational test.

.2 Testing shall be done in phases under the direction of the Departmental Representative.

.3 The contractor shall provide all test equipment including 2 way radios.

.4 All test equipment such as digital thermometers, humidistat, volumeters and milliamp and volt meters shall be certified as accurate by an independent testing laboratory no later than 2 months prior to the tests.

.5 Notify the Departmental Representative in writing at least 21 working days before testing is to take place stating the following:
  .1 Location and part of the system to be tested.
  .2 Describe testing procedure, names of testing personnel and anticipated results.

.6 Obtain approval of testing procedure and personnel before proceeding.
.7 Provide all necessary personnel and coordination with other trades.

.8 Perform tests in presence of Departmental Representative.

.9 Demonstrate the proper operation of each component.

.10 Correct any deficiencies and re-test in the presence of the Departmental Representative, until designated part of the system performs satisfactorily.

.11 Acceptance of tests by the Departmental Representative shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

.12 Pre-installation Tests:
  .1 This refers to equipment that is to be field tested just prior to their installation.
  .2 Instruments shall be: differential pressure transmitters, VAV downstream duct static pressure transmitters, and dp switches used for dirty filter indication and fan status.
  .3 Provide, additional test equipment, inclined manometer, digital micromanometer, milliamp meter, a source of adjustable air pressure.
  .4 After setting, the zero and span transmitters are to be tested in 10% increments through their entire range both on an increase and decrease of pressure.
  .5 Transmitters tracking in both directions within 5% shall be marked "approved" for installation by the Departmental Representative. Transmitters above 5% error are to be rejected.
  .6 DP switches shall open and close within 10% of setpoint.

.13 Completion Tests:
  .1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.
  .2 Give Departmental Representative 14 days notice of the completion tests.
  .3 Test and calibrate all field and OWS hardware including stand alone capabilities of each Controller.
  .4 Verify each A to D convertor.
  .5 Check and calibrate each AI using a calibrated digital thermometer, humidistat, volumeter or transducer.
  .6 Check each DI to insure proper settings and switching contacts.
  .7 Check each DO to insure proper operation and lag time.
  .8 Check each AO to insure proper operation of valves and dampers. Verify tight closing and input out signals.
  .9 Check all operating software.
  .10 Check all application software. Provide samples of all logs and commands.
  .11 Verify each CDL including energy optimization programs.
  .12 Debug all software.

.13 Blowout flow measuring and static pressure stations with high pressure air at 100 psi.

.14 Final Operational Acceptance Test:

.1 A final operational test of not less than thirty (30) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total.

.2 Demonstrate that it is functioning properly in accordance with all requirements of this specification.

.3 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software.

.4 If the equipment operates at an average effectiveness level (AEL) of at least 99% during the performance test period of thirty (30) consecutive calendar days, it will be deemed to have met Standard of Performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification.

.5 In the event the required AEL is not reached during the initial thirty (30) consecutive calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for thirty (30) consecutive calendar days. The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period.

.6 Downtime shall result whenever the EMCS is unable to fulfil all required functions detailed within this specification due to any malfunction of either hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed.

.7 System downtime for each incident shall be measured by those intervals during the performance period between the time that the Contractor or duly authorized representative is notified of equipment failure and the time that the system is returned to proper operating condition. Notification of down time shall be by means of OWS located in the contractors office and a modem to the system. Downtime of the system resulting from the causes as follows will not be considered as system failures:

.1 Downtime resulting from an outage of the main power supply in excess of the capability of any back-up power source(s), provided that the automatic initiation of all back-up sources was accomplished and provided that the automatic shutdown and restart of components fulfils the requirements of this specification.

.2 Failure of a communications link, provided that the Controllers automatically and correctly operates in the stand-alone mode and provided that the failure was not due to a failure of contractor furnished equipment.

.3 A functional failure resulting from an individual sensor or controller provided that the system has recorded the fault, the mechanical equipment is defaulted to the fail-safe mode, and that the AEL of the total of sensors and controllers is at least 99% during the thirty-day test period.

1.19 FINAL COMMISSIONING

.1 When the contractor has satisfied himself as to proper system operation he shall advise the Departmental Representative to establish a date for detailed Final Acceptance. This will involve a point by point check of all hardware and software items including graphics and displayed data, as well as perform tasks as directed.

.2 This phase of the work shall be carried out under the complete direction of the Departmental Representative or his authorized representative.

.3 Provide 2 way radios and all test equipment as previously specified.

.4 Provide at least 2 technical personnel capable of re-calibrating all field hardware and modifying software.

.5 Provide a detailed daily schedule showing items to be tested and personnel available.

.6 The key document for recording the commissioning shall be a listing of the system data base. This listing shall include the key name (i.e. AH7-SAT) English description, point type and address, Departmental Representative units, low and high limits, and a space for remarks and Departmental Representative's acceptance signature.

.7 The Departmental Representative's acceptance signature shall also be required for all executive and application programs as specified.

1.20 OPERATION AND DESIGN DATA

.1 Submit operation, maintenance and design data for Maintenance incorporation into manuals specified in Section 01 78 00 – Closeout Submittal and as herein specified.

.2 Provide "as-built" drawings in both hard and soft copy showing all changes to original drawings and submittal as well as addenda and contract extras.

.3 Operations and Maintenance Manual shall include:
   .1 Names, address, and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representatives of each.
   .2 Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point/object reports, trending data, overriding computer control, and changing setpoints and other variables.
   .3 One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point/object database creation and modification, program creating modification, and use of the editor.
   .4 Departmental Representative, installation, and Maintenance Manual(s) that explain how to design and install new points/objects, panels and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

.5 A listing and documentation of all custom software created using the programming language, including the setpoints, tuning parameters and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.
.6 One set of magnetic/optical media containing files of all colour graphic screens created for the project.
.7 A list of recommended spare parts with part numbers and suppliers.
.8 Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
.9 Complete original issue flash drives for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
.10 Licenses, guarantee, and warranty documents for all equipment and systems.
.11 Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

1.21 TRAINING

.1 In addition to the training listed below provide an "on line" or "CD" or "Digital file" for each element of the system.

.2 Within 30 days prior to start of training provide a complete hour by hour schedule for approval, complete with a brief overview of content of each portion.

.3 List the name of the person conducting each session and the visual and audio aids employed.

.4 Departmental Representative may monitor the training program and will have the right to modify the schedule, content as well as replace instructors deemed unqualified.

.5 Indicate how the EMCS training schedule is coordinated with other training programs in HVAC and Electrical Systems.

.6 Instructions to Personnel:
.1 General:
.1 The Contractor shall provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Departmental Representative has the right to approve/reject the instructors based on their qualifications. The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum. A training manual in English shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor. A person-week shall be considered as 40 hours, 8:00 am to 12:00 noon, and 12:30 pm to 4:30 pm Monday through Friday.

.2 Training Program:
  .1 The training program shall be accomplished in two phases over a 6 month period.
  .2 First Phase:
    .1 This phase shall be for a period of 2 days prior to the 30-day test period at a time mutually agreeable. Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. This phase shall be augmented with on-the-job training during the 30 days acceptance period. First Phase training shall include the following:
      .1 General EMCS architecture (overview).
      .2 System Communications (overview).
      .3 Operation of computer and peripherals (overview).
      .4 Operator interface functions for control of HVAC Systems (detailed).
      .5 Control Descriptive Logic (detailed for each system).
      .6 Report Generation (overview).
      .7 Elementary preventive maintenance (detailed).
.3 Second Phase:
  .1 This phase shall be conducted eight weeks after system acceptance for a period of 2 days. Training will be provided for three categories of personnel: operators, equipment maintenance personnel and programmers. All classes may run with multiple instructors on a pre-arranged schedule. The training shall include as a minimum, but not be limited to:
    .1 Operator Training: operators, equipment maintenance personnel and programmers, will be given a condensed version of phase one training.
    .2 Equipment Maintenance: minimum of 2 days training, in the maintenance of EMCS equipment. This training shall include:
      .1 General equipment layout.
      .2 Trouble shooting of all EMCS components.
      .3 Preventive maintenance of all EMCS components.
      .4 Sensors and controls maintenance and calibration.
    .3 Programmers: minimum of 2 days training on the following subjects.
      .1 System architecture (10%)
      .2 Application Program (15%)
      .3 Colour Graphic Generation (10%).
      .4 Controller Programming (50%).
      .5 Troubleshooting and debugging (15%).
    .4 Additional Training:
      .1 Since the Departmental Representative may require personnel to have more in-depth understanding of the hardware or software, additional training must be available from the contractor and/or manufacturer. Training must be suitable for personnel who have graduated from technical schools teaching solid state electronics or personnel who

have had a minimum of two years experience working with solid state digital equipment theory and/or applications and for programming personnel with a minimum of two years experience in programming techniques. If such in-depth training is required it will be contracted for at a later date. Provide a List of courses offered and note courses recommended to train system supervisory personnel. Each recommended training course shall be individually listed by name, including duration and approximate cost per person per week.

1.22 WARRANTY

.1 Warrant the EMCS to be free from defects in workmanship and material for a period of two years from the date of final acceptance.

.2 During the warranty period, this Division shall furnish all labour and material to replace or repair all items or components which failed due to defects in workmanship or material.

.3 The above warranty shall include all new system and application software installed under this contract.

1.23 SERVICE CONTRACT

.1 Provide a complete service contract for a period of 12 months from the date of acceptance.

.2 During this service contract the controls contractor shall maintain at his office an "on line" monitoring of the system through a web-based connection to the system.

.3 Repair and servicing of the system shall be completed in 24 hours after detecting a fault.

.4 Service response time to site must be 4.0 hours or less following a serious control system issue or lab ventilation system failure.

1.24 ACCEPTABLE CONTRACTOR/SUPPLIERS

.1 All control equipment and installation shall be the product and service of one manufacturer unless otherwise specified.

.2 Acceptable materials of control equipment for the purposes of this project are:
  .1 Controls and Equipment.
  .2 Siemens
  .3 Pheonix
  .4 JCI
  .5 A.E.M

END OF SECTION

Part 1 General

1.1 GENERAL

.1 The system shall network operator workstations and Programmable Controllers (MCUs) as shown on the attached system architecture drawing. Inherent in the system design shall be the ability to expand or modify the network via BACNET IP network.

1.2 WORKSTATION/MCU PANEL SUPPORT

.1 Operator workstations and MCU panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

1.3 DYNAMIC DATA ACCESS

.1 All operator devices, either network resident or connected via Ethernet LAN or gateways, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification or building equipment.

1.4 GENERAL NETWORK DESIGN

.1 Network design shall include the following provisions:

.1 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices. The minimum baud rate shall be 1 Megabaud.

.2 Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.

.3 Detection and accommodation of single or multiple failures of either workstations, MCU panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

.4 Message and alarm buffering to prevent information from being lost.

.5 Error detection, correction, and retransmissions to guarantee data integrity.

.6 Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.

.7 Commonly available, multiple source, networking components and protocols shall be used to allow the system to coexist with other networking applications such as office automation. ETHERNET, and IBM Token Ring are acceptable technologies.

.8 Synchronization of the realtime clocks in all MCU panels shall be provided.

1.5 DIAL-UP COMMUNICATIONS

.1 Auto-dial/auto-answer communications shall be provided to allow MCU panels to communicate with remote operator work stations on an intermittent basis via telephone lines.

1.6 DIAL-UP STAND-ALONE PANELS

.1 Auto-Dial panels shall automatically place calls to workstations to report critical alarms, or to upload trend and historical information for archiving.

.2 Controllers (MCUs) shall analyze and prioritize all alarms to minimize the initiation of calls. Non-critical alarms shall be buffered in memory and reported as a group of alarms, or until an operator manually requests an upload of all alarms.

1.7 WORKSTATIONS

.1 Operators at Web-Based workstations shall be able to perform all control functions, all report functions, and all database generation and modification functions as described for workstations connected via the local area network. Routines shall be provided to automatically answer calls, and either file or display information sent from remote panels. The fact that communications is taking place with remote control systems over telephone lines, Ethernet LAN , or Web-Browser shall be completely transparent to an operator.

.2 An operator shall be able to access remote buildings by selection of any facility by its logical name. The web based program shall maintain a user-definable cross-reference of buildings and associated telephone numbers, so the user shall not be required to remember or manually dial telephone numbers.

.3 A workstation may serve as an operator device as well as a network workstation for multiple controllers or networks. Alarm and data file transfers handled via web based transactions shall not interfere with local area network activity, nor shall local area network activity keep the workstation from handling web based communications.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Programmable Controllers referred to in this section include Local Control Units (LCU), and Terminal Control Units (TCU).

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 and as specified herein.

.2 One-line diagram from sensor and control points to Field Interface device and/or Terminal Control Unit including all components and cables.

.3 Terminal cabinets, including termination listings.

.4 Control diagrams, sequences for operation, and Control logic for each controlled area.

1.3 GENERAL DESCRIPTION

.1 The Programmable Controllers are to be stand-alone intelligent controllers. The "controller" is defined as the Processor, field interface and communication interface. The Controller will have the following characteristics:
   - .1 Incorporate a programmable microprocessor, non-volatile program memory, random access memory, power supplies and appropriate communication interfaces as required to perform it's functions.
   - .2 Incorporate a communication interface port for communication to the Master Control Unit (MCU) and utilize a multi-drop communication bus as the communication link. Be capable of interfacing to a local computer terminal.
   - .3 Interface with field sensors via Field Interface Equipment which may be part of the PCU or located remotely. The PCU shall execute it's logic and control (Direct Digital or Closed Loop Process Control) associated equipment without interacting with any other Processor.
   - .4 Basic functional requirements to include scanning of digital/analog inputs, digital change of state (alarm) monitoring, analog input (alarm) monitoring, on-off digital control with configure-able logic, analog control using configure-able logic (including PID) with adjustable dead bands and deviation alarms, control of HVAC systems, specified under sequence of operation instructions. Optimization such as economizers and unoccupied cycle shall be executed by the controller.
   - .5 Controller capacity to be a minimum of 12 I/O points of which a minimum are to be 2 analog output, 4 analog input, 4 digital input and 2 digital output. All points of a "system" are to be located within one controller.

Part 2 Product

2.1 CONTROLLER ARCHITECTURE

.1 The controller shall be comprised of the following components:
   - .1 Complete with enclosure and microprocessor peripheral devices such as memory, power supplies and communication interfaces.

.2 Field interface Equipment (integral to the controller or remote) which interface to all Digital and Analog Input and provide Digital or Analog control output signals under PCU control.

.3 MCU communications port for communications to the MCU.

.4 Computer Terminal Communication port for communications to the local computer terminal.

2.2 APPLICATION CONTROL UNIT (ACU)

.1 Application control unit (ACU) comprised of a microprocessor capable of supporting all necessary software and hardware to meet these specifications. Designed to provide control functions of a typical air handling unit or water system(s).

.2 Minimum addressable memory will be at manufacturer's discretion and will be as a minimum support all performance and technical specifications. Memory is to be divided into non-volatile (EEPROM) and Random Access (RAM) memory. All operating system, executive, application, subroutine etc. and other configuration description software, shall reside in non-volatile memory such as EEPROM. Tape or disc media is not acceptable. All control logic, applicable functions, and operating data shall reside in battery backed RAM or EEPROM. That is, data that is required to be modifiable from an operational standpoint, such as set points, alarm limits and PID constants must remain in RAM or EEPROM and hence modifiable on-line through the operator panel or remote operator interface. RAM must include battery backup for a power failure. All operating data must be down-line loadable from archive operator work station.

.3 The LCU shall include as a minimum 2 interface ports for connection of MCU controller and local computer terminal.

.4 Environmental Requirements: The unit shall be capable of operating properly under conditions of 0°C to 44°C and Relative Humidity of 10% to 90% (non-condensing).

.5 Controller unit to be supplied in wall mounted enclosure. The enclosure shall accept conduit entry.

.6 Provide surge and low voltage protection.

.7 Field interface can be located in the LCU or may be mounted remote. The electronic design shall be such that shorts, opens or grounds on any one input or output will not interfere with other inputs or outputs.

.8 Equipment arrangement will ensure that line voltage circuits are physically separated from DC logic circuits and that maintenance can be performed on either circuit with minimum hazards to technician and equipment.

.9 Power supplies shall be included for the operation of the LCU and associated field equipment.

.10 In the event of loss of communications with, or failure of the MCU, this controller shall continue to perform control of the associated equipment. Controllers that use defaults or fail to open or closed position will not be acceptable.

.11 The LCU shall have convenient screw type terminals for field wiring.

.12 Analog input interface equipment will meet the following technical criteria:
- .1 Convert analog signals to a digital format with a 12 bit analog to digital resolution.
- .2 To have provision for the following input signal types and ranges:
- .1 4-20 milliamps
- .2 0-10 volts DC
- .3 Common mode signal rejection to be greater than 60 db to 60 Hz.

.13 Analog Output interface equipment will meet the following technical criteria:
- .1 Will convert digital data from the processor to an acceptable analog output signal with a minimum 8 bit D/A resolution.
- .2 Have the following output signal types and ranges:
  - .1 4-20 milliamps
  - .2 0-10 volts DC

.14 Digital Input interface equipment to meet the following technical criteria:
- .1 Ability to relay contact closure
- .2 Meets the IEEE-472 surge withstand capability. Accepts pulsed inputs up to 10 K Hz.

.15 Digital Output interface equipment to meet the following technical criteria:
- .1 The output shall switch up to .5 amps at 24 volts AC.
- .2 Operational relay interface to switch 5 amps at 220 volts AC.

.16 The LCU shall have 33% spare point capacity of each type without the addition of cards, terminals, etc.

2.3 TERMINAL UNITS

.1 The Terminal Controller shall be comprised of a microprocessor capable of supporting all necessary software and hardware to meet the specifications.

2.4 SOFTWARE

.1 General Requirements
- .1 Software shall include but not be limited to definitions and operating systems executive, communications, application programs, operator interface and logic control.
- .2 Software to include any "firmware" or instructions which are programmed into ROM or other non-volatile memory.
- .3 The overall design philosophy of software with special emphasis on operator interfacing must use a management by exception philosophy (i.e. report abnormalities by priorities and by order of event occurrences).

.2 Program and Data Storage
- .1 All executive programs will be resident in read only memory or other non-volatile media. Site configuration data will also be maintained in a non-volatile manner. Battery backed RAM may be used.
- .2 Operating data, such as set-points, and alarm limits must be maintained in a battery backed Random Access Memory (RAM) and hence modifiable by the operator.

.3 The contractor to submit with his proposal, information on how control algorithms site configuration are generated and maintained.

.3 Operation Software and Firmware

.1 The PCU and associated software and firmware will support a local computer terminal access/display panel as specified.

.2 Software must be included to handle the remote communications port. This port is included for present or future communications with an MCU controller.

.3 Operating System software to be configure-able to support any or all devices which are supported by the PCU.

.4 A "global" or "common" value capability is required to allow a monitored status/value to be passed to a remote computer or controller for use in a control strategy by another controller. As well, the software must be able to accept a "global" value from a remote computer or controller and use this value in a local strategy (i.e. be able to pass or accept an Outside Air Temperature reading for use in any strategy by either this controller or a remote controller).

.4 LCU Program Application

.1 The LCU controller shall be generic and the controller software shall be configure-able to meet the operating requirements as specified in sequence of operation. The software configuration shall be down-loaded into the controller from a computer terminal.

.2 The controller shall execute the sequence of operations as specified.

.5 TCU Program Application

.1 The TCU controller shall be generic and the controller software shall be configure-able to meet the operating requirements as specified in the sequence of operation. The software configuration shall be down-loaded into the controller from a computer terminal.

.2 The controller shall execute the sequence of operations as specified.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Provide all remote sensing points and instrumentation as required for the complete Energy Monitoring and Control System. All sensors shall have the accuracies as stated hereinafter. Hysteresis, relaxation time, span, max./min. limits, etc. shall also be accounted for in all application of sensors and controls.

.2 All instruments of a particular category shall be of the same type and manufacturer.

.3 All external trim material shall be completely corrosion resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.

.4 Use standard conduit box termination with slot screwdriver compression connector block unless otherwise specifically stated.

.5 Operating conditions °0 to 32°C with 10-90%RH (non condensing) unless otherwise specifically stated.

.6 Manufacturers installation instructions shall be supplied for all equipment supplied. All equipment shall be installed in accordance with manufacturers recommended methods and procedures.

Part 2 Products

2.1 TEMPERATURE SENSORS

.1 General: temperature sensors shall be Thermisters.

.2 The following shall apply to resistance temperature sensors as applicable.

.3 Temperature sensors shall be of the following types.
  - .1 Room type
    - .1 11,000 ohm with accuracy of +/- 1/2C at 20°C. Sensors shall have 96 segment LCD display and programmable buttons for setpoint adjustment and override.
  - .2 General Purpose Duct type
    - .1 Suitable for insertion into air ducts at any angle, insertion length of 457 mm as noted on schedule or drawings.
  - .3 Spring-Loaded Thermowell type
    - .1 Spring loaded construction with compression fitting for 20 mm NPT well mounting. Lengths of 100 mm to 150 mm as noted.
  - .4 Averaging duct type:
    - .1 Continuous filament with Immersion length of 1.5m minimum. Probe to be bent, at field installation time, to a minimum radius of 100 mm at any point along the probe length without degradation in performance.

.5 Outside Air type:
  .1 Complete with noncorroding shield designed to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, probe length of 100-150 mm.

2.2 HUMIDITY SENSORS

.1 Provide humidity sensors as directed with the following minimum specifications:
  .1 Range of 5-90% RH at minimum.
  .2 Operating temperature range of 0°C to 60°C.
  .3 Absolute accuracy of +5% RH for duct sensors and 2% for room sensors.
  .4 Stainless steel sheath construction complete with integral shroud to enable specified operation in air streams of up to 10 m/sec.
  .5 Maintenance of Sensor to be by a simple field method such as solvent or mild detergent solution washing, to remove anticipated airborne contaminants.
  .6 Maximum sensor non-linearity of +5% RH with defined curve.
  .7 Room humidity sensors shall be located at the inlet to a RA grille.
  .8 Duct mounted sensors shall be located such that the sensing element is between one third and two thirds the distance across the duct interior from any duct wall.
  .9 Sensors shall be unaffected by external transmitters such as walkie-talkies.

2.3 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Provide differential pressure transmitters having the following min. specifications:
  .1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, glycol, or steam as applicable.
  .2 Output signal of 4-20 mA into maximum of 500 ohm load.
  .3 Output variation of less than 0.2% full scale for supply voltage variations of +10%.
  .4 Combined non-linearity repeatability and hysteresis effects not to exceed +0.5% of full scale output over entire range.
  .5 External exposed integral zero and span adjustment.
  .6 Temperature effect of +1.5% full scale/50°C or less.
  .7 Output short circuit and open circuit protection.
  .8 Over-pressure input protection to a minimum of twice rated input.
  .9 Differential Pressure ranges as shown in point schedule.

2.4 STATIC PRESSURE TRANSMITTERS

.1 Fan system static pressure sensing unit to be a multipoint element w/ self-averaging manifold. Maximum pressure loss of 20 mm (.075 in wg) at 1000 M2 (2000 fpm): accuracy of 1% of actual duct static.

.2 Output of 4-20 mA linear into maximum of 500 ohm load.

.3 Calibrated span: not greater than 50% of static pressure at maximum flow.

.4 Accuracy: 0.4% of span.

.5 Repeatability: within 0.5% of output.

.6 Linearity: 1.5% of span.

.7 Deadband or Hysteresis: 0.1% of span.

.8 External exposed zero and span adjustment.

.9 Provide a Dwyer magnehelic gauge to indicate pressure.

2.5 TEMPERATURE SWITCHES

.1 Provide High/Low temperature switches for range as indicated on point schedule.

.2 Temperature sensing element shall be liquid, vapour or bimetallic type.

.3 Adjustable set-point and differential.

.4 Snap action type rated at 120 Volts, 15 amps or 24 V DC as required.

.5 Sensors shall operate automatically and reset automatically. Sensors used for freeze detection or fire detection shall be manually reset type.

.6 Temperature switches shall be of the following types:
  - .1 Room type - suitable for wall mounting on standard electrical box with or without protective guard.
  - .2 General Purpose Duct type - suitable for insertion into air ducts, insertion length of 457 mm.
  - .3 Thermowell type - with compression fitting for 20 mm NPT well mounting, length of 100 mm. Immersion wells shall be stainless steel.
  - .4 Freeze detection type - continuous element with insertion length of 6000 mm minimum, suitable for duct mounting to detect the coldest temperature in any 30 mm section.
  - .5 Strap-on type - with helical screw stainless steel clamps.

.7 Temperature accuracy shall be +1°C.

2.6 TANK LEVEL SWITCH

.1 Provide level switches in tanks to indicate high/low level alarm as shown in the point schedule.

.2 Level switch to be mounted in top of tank in threaded coupling.

.3 Operating temperature of switch and components to be 120°C.

.4 Contacts shall be mercury switch or snap action rated 15 amp at 120 V AC.

.5 Set-point and differential shall be adjustable.

2.7 SUMP LEVEL SWITCH

.1 Provide level switches in building sumps as noted in the point schedule to indicate high level alarms.

.2 Switches shall be mercury tube switch sealed in waterproof and shockproof enclosure.

.3 Suspend float in sump from flexible cord and weight supplied with switch.

.4 Contacts shall be rated at 15 amps @ 120 VAC.

2.8 ELECTRICAL RELAYS

.1 Provide double Voltage DPDT relays for control and status indication of alarms and/or electrical starters and equipment where shown on point schedule.

.2 Relay coils shall be rated for 120 V or 24 V. Where other voltages occur provide transformer.

.3 Contacts rated at 5 amps at 120 V AC.

.4 Relays to be plug in type with termination base.

2.9 CURRENT TRANSDUCER

.1 Provide current transducers with range of 10A, 20A, 50A, 100A, 150A and 200A full scale.

.2 Current transducers shall measure line current and produce a proportional signal of 0-5 vdc.

2.10 CONTROL DAMPERS

.1 Construction: Blades shall not exceed 152.4 mm wide or 1219.2 mm long. Modular maximum size 1219 mm wide x 2438 mm high. Multiple sections to have stiffening mullions and jack shafts.

.2 Materials:
  .1 Frame: 2.3 mm (13 gauge) galvanized sheet steel.
  .2 Blades: two sheets 0.5 mm (22 gauge) or 1.6 mm (16 gauge) galvanized steel.
  .3 Bearings: oil impregnated sintered bronze. Provide additional thrust bearings for vertical blades.
  .4 Linkage and shafts: zinc plated steel.
  .5 Seals: Replaceable neoprene seals or stainless steel spring on sides, top and bottom of frame and along all blade edges and blade ends.
  .6 Exhaust and fresh air dampers to be insulated blade type with thermal break and gasketted seals complete with frame.

.3 Performance:
  .1 .02 L/s/m2 maximum allowable leakage against 1000 Pa static pressure.
  .2 Temperature range: minus 50°C to 100°C.

.3 Dampers mixing cold and warm air to be parallel blade mounted at right angles to each other with blades opening to mix the air streams.

2.11 CURRENT SENSING RELAY

.1 Provide current sensing relay having the following minimum capabilities:
- .1 Relay to be complete with metering transformer ranged to match load being metered.
- .2 Relay shall be provided with plug in base and shorting shunt (if required) to protect current transformer when relay is removed from socket. Current transformer shall be available for single or three phase metering into single relay.
- .3 Current relay shall have adjustable latch level, adjustable delay on latch and a minimum differential of 10% of latch setting between latch level and release level.
- .4 Three phase application, shall provide for discrimination between phases to allow detection of worst case selection. Current relay shall be powered from control circuit of motor starter being metered and shall be suitable for mounting in the motor starter cabinet.
- .5 Relay contacts shall be capable of handling 10 amps at 240 volts.

2.12 DAMPER OPERATORS ELECTRONIC

.1 Provide push-pull type electronic proportional damper operators where Operators indicated or required.

.2 Spring return for "fail-safe" in Normally Open or Normally Closed position where required.

.3 Size operators to control dampers against maximum pressure or dynamic closing pressure whichever is greater.

.4 Power Requirements 5 VA maximum at 24 V AC.

.5 Operating Range 0-20 V DC.

2.13 CONTROL VALVES

.1 Provide control valves as shown on drawings or listed on valve schedule.

.2 Valves 50 mm and smaller to be bronze with screw end connections. Valve 62 mm and larger to be cast iron with flanged end connections.

.3 All trim to be 316 SST.

.4 Valves to provide tight shut-off. Maximum leakage of 0.5% of rated flow. Close-off pressure shall be 150% of total system (pump) head for two-way and 100% of total system head for three-way.

.5 Valves to be Normally Open, Normally Closed or 3-way as shown.

.6 Valves to have linear or equal percentage flow characteristics as indicated.

.7 Modulating control valves shall be sized as follows:
  .1 Two-way – 50% of pressure difference between supply and return mains of 35 KpA, whichever is greater.
  .2 Three-way – Twice the pressure drop through the load or 35 KpA maximum.

.8 Range ability of valves to be minimum 50:1.

2.14 ELECTRONIC/ELECTRIC VALVE ACTUATORS

.1 Provide Electronic/Electric Valve Actuators with spring return to normal.

.2 Construction to be steel, cast iron or cast aluminum.

.3 Control Voltage 0-20 V DC or 24 V AC.

.4 Positioning time - to suit application.

2.15 PRESSURE SWITCHES

.1 Provide pressure or differential pressure switches for ranges as indicated on point schedule.

.2 Pressure sensing elements shall be bourdon tube, bellows or diaphragm type.

.3 Adjustable setpoint and differential.

.4 Pressure switches shall be snap action type rated at 120 volts, 15 amps AC or 24 volts DC.

.5 Sensor assembly shall operate automatic-ally and reset automatically when condition returns to normal.

.6 Sensor Ratings: Sensors shall have the following pressure and accuracy ratings:
  .1 Chilled water sensors shall be rated at 125 psig.
  .2 Hot water sensors shall be rated at 125 psig.
  .3 Pressure switches for fan operation shall have range of 0 to 3000 Pa and adjustable differential from 10 to 300 Pa.
  .4 All sensors shall have an isolation valve and snubber installed between the sensor and pressure source.

2.16 TERMINAL UNIT CONTROLLER

.1 Ship DDC controllers for VAV Boxes manufacturer for mounting at the factory.

Part 3 Execution

3.1 GENERAL

.1 Provide all remote sensing points and instrumentation as indicated and/or required for the complete operational capability of the Energy Monitoring and Control System.

.2 All equipment shall be installed according to manufacturers' published instructions.

3.2 TEMPERATURE HUMIDITY SENSORS

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

.2 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.

.3 Outdoor installation shall be weather-proof construction in Nema 12 enclosures. These installations shall be protected from solar radiation and wind effects by stainless steel shields.

.4 Sensors located in finished spaces shall be with brushed stainless steel covers and guards where indicated.

.5 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only, and shall not be located in dead air spaces. The location shall be within the vibration and velocity limits of the sensor. Where an extended surface element is required to properly sense the average temperature it shall be securely mounted within the duct to measure the best average temperatures. Elements shall be thermally isolated from brackets and supports to respond to air temperature only. Sensor element to be supported separately and not connected to coils or and filter racks.

.6 Wells shall be installed for all piping installations. Where pipe diameter is less than the insertion length of the well, the well shall be installed at an elbow location to effect proper flow across entire well area. Well when installed shall not restrict flow in piping by more than 30% (i.e., well shall not represent more than 30% of pipe as measured on a cross section by area).

3.3 TRANSMITTERS

.1 Temperature Transmitters, Humidity Transmitters, Current to Pneumatic Transducers, Solenoid Air Valves, Controllers and relays to be installed in NEMA I enclosures.

.2 Panels to be either free standing or wall mounted enamelled steel cabinets with hinged and key locked front door. Arrange for conduit and tubing entry from top, bottom or either side.

.3 Panels shall be modular multiple panels being used if required for capacity in any particular location. They shall handle all requirements with space to accommodate an additional 20% without adding further cabinets.

.4 All panels shall be lockable with same key.

.5 All wiring and tubing within panels to be located in trays or individually clipped to back of panel, and clearly identified.

.6 Field mounted transmitters and sensors to be properly supported on pipe stands or channel brackets, all wall mounted devices to be mounted on plywood panel properly attached to the wall.

.7 All field devices to be properly identified.

.8 Flow measuring stations to be capped until ducts are cleaned.

3.4 TESTING

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

.2 Submit samples at random from equipment shipped, before installation, as requested by the Departmental Representative for testing by the government. Devices not meeting performance and accuracy specified shall be replaced by proper equipment.

.3 Refer to Section 25 for detailed testing requirements of static and velocity transmitters.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Environmental Condition:

.1 The Master Control Units and it immediate associated devices shall be able to operate properly under environmental conditions of 0°C to 44°C and a relative humidity of 10 to 90 percent non-condensing.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 34 00 and as specified herein.

.2 One-line diagram from sensor and control points to Field Interface device and/or Master Control Unit including all components, signal values and cables.

.3 Terminal cabinets, including termination listing.

.4 Control diagrams and sequences of operation for each system. Sequence to be shown as control logic flow diagrams using industry standard symbols.

.5 Note all shop drawings to be provided in both soft and hard copy.

1.3 GENERAL DESCRIPTION

.1 The Master Control Unit (MCU) is to be a stand-alone intelligent controller with the following characteristics:

.1 Standalone MCU panel shall be microprocessor based, multi- tasking, multi-user, real-time digital control processors with the capability of supervising other lower level Programmable Controllers through a secondary network. Each standalone MCU panel shall consist of modular hardware with plug-in processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification including spare point capacity. Provide a MINIMUM OF ONE MCU per mechanical room.

.2 The MCU shall provide a LAN Interface for peer-to-peer communication between Master Controllers and at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop work stations, PC work stations, and MCU mounted or portable Operator's Terminals. Standalone MCU panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or Operator's Terminals.

.3 Controller to interface field sensors via Field Interface Equipment which may be located in the Processor cabinet or located remotely. The processor shall execute programmable logic control (Direct Digital or Closed Loop Process Control) of associated HVAC equipment without interacting with any other Processor or Operator Work Station.

.4 Basic functional requirements to include scanning of digital/analog input, digital change of state (alarm) monitoring, analog input (alarm) monitoring, on-off digital control with programmable logic (including PID) with adjustable dead bands and deviation alarms, control of HVAC systems, specified under sequence of operation instructions or as required to meet the design intent. Optimization functions such as scheduled stop-start optimal start-stop, timed setpoint-reset, etc shall be resident in the MCU (or terminal units if applicable).

.5 MCU capacity to be a minimum 16 I/O points of which a minimum are to be 2 Analog Output, 6 Analog Input, 4 Digital Input and 4 Digital Outputs. Units may be expandable to 64 points. All points of a "system" to be located within one controller.

1.4 INSTALLATION REQUIREMENTS

.1 Provide all necessary electrical wiring as required from the local 120 volt branch circuit panel board for all controller equipment including the processor, applicable terminal devices and applicable field interface devices. Install tamper locks on breakers of circuit panel.

.2 Use emergency power supply where available, specifically if controlled equipment must operate in emergency mode.

.3 Controller (s) to be installed as directed or shown on drawings in secure enclosures.

.4 33% spare capacity shall be provided for each MCU or mechanical room on approval of Departmental Representative without the addition of cards, terminals, or software. Spares of each type of point must be provided.

Part 2 Equipment

2.1 CONTROLLER PROCESSOR-UNIT

.1 The processor shall be comprised of a 16 bit microprocessor capable of supporting all necessary software to meet these specifications. The CPU idle time must not be less than 30% when system is configured to maximum input and output with worst case program use.

.2 The building controller shall have as a minimum standard SRAM of 256KB, DRAM of 1MB and 1MB of flash memory as non-volatile. Memory is to be divided into non volatile system, executive, application subroutines, etc. and other configurations description software, shall reside in non-volatile memory. Tape or disc media is not acceptable. All control description logic (CDL) application functions and operating data or software shall reside in battery backed RAM. That is, data or CDL software that is required to be modifiable from an operational standpoint such as schedules, setpoints, alarm limits and PID constants and CDL must remain in RAM and hence modifiable on-line through the operator panel or remote operators interface. RAM must include battery backup for a minimum 144 hours to eliminate operating data reload in case of power failure. Complete RAM Memory must be downline loadable from Operator Work Station, (Gateway), or locally installed compact disk drive.

.3 Processor Unit to include an uninterruptible clock, with an accuracy of +5 seconds per month and capable of deriving month/day/hour/min/seconds. Rechargeable batteries to provide a minimum of 144 hours of operation in the case of power failure.

.4 Processor Unit to be supplied in wall mounted cabinet with hinged and keylock front door. Arrange for conduit entry from top, bottom or either side.

.5 Controller shall be able to operate at 90% to 110% of nominal voltage and shall perform an orderly shutdown below 80% nominal voltage.

2.2 LOCAL OPERATOR TERMINAL

.1 Each MCU shall be capable of supporting an operated terminal for local command entry, instantaneous and historical data display, and program additions and modifications.

.2 The MCU Operator Terminal shall simultaneously display a minimum of 16 points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.

.3 The operator functions provided by the MCU Operator Terminal shall include, but not be limited to, the following:
  - .1 Start and Stop Points
  - .2 Modify Setpoints
  - .3 Modify PID Loop Setpoints
  - .4 Override PID Control
  - .5 Change Time/Date
  - .6 Add/Modify Start/Stop Weekly Scheduling
  - .7 Add/Modify Setpoint Weekly Scheduling
  - .8 Enter Temporary Override Schedules
  - .9 Define Holiday Schedules
  - .10 View Analog Limits
  - .11 Enter/Modify Analog Warning Limits
  - .12 Enter/Modify Analog Alarm Limits
  - .13 Enter/Modify Analog Differentials

.4 The MCU Operator Terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any other MCU panel in the network.

.5 Operator access at all MCU Operator Terminals shall be identical to each other. Any password changes shall automatically be downloaded to all controllers on the network.

.6 The MCU operator terminal shall provide prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.

2.3 INPUT/OUTPUT BOARD

.1 Will convert digital data from the processor.

.2 To an acceptable analog output signal with a minimum 10 bit D/A resolution.

.3 Have the following output signal types and ranges:
- .1 4-20 Milliamps
- .2 0-5 Volts DC and 0-10 VDC.
- .3 Thermister – Resistive signal types for any status or sensing device.
- .4 Meets IEEE-472 surge withstand capability

.4 Digital Input Equipment to meet the following technical criteria:
- .1 Able to sense relay contact closure.
- .2 Meets IEEE-472 surge withstand capability.
- .3 Accepts pulsed inputs at frequencies up to 10 K Hz.

.5 Digital Output Equipment to meet the following technical criteria:
- .1 The output shall switch up to .5 amps at 24 volts AC.
- .2 Optional relay interface to switch 5 amps at 220 volts AC.

.6 Controller input/output board shall support plug-and-play 1/0 modules or built-in HOA modules.

.7 Controller input/output board shall have red LED’s providing input status indication.

.8 Controller input/output board shall have 24 VDC terminal for directly connected active transducers.

2.4 SURGE AND PROTECTION TRANSIENT

.1 Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent protection with IEEE Standard 587-1980.

2.5 POWERFAIL RESTART

.1 In the event of the loss of normal power, there shall be an orderly shutdown of all standalone MCU panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 150 hours.

.2 Upon restoration of normal power, the MCU panel shall automatically resume full operation without manual intervention.

.3 Should MCU panel memory be lost for any reason, the user shall have the capability of reloading the MCU panel via the remote OWS, the local RS-232C port, via telephone line dial-in or through the OWS.

2.6 SOFTWARE

.1 General Requirement:
  .1 Software shall include but not be limited to operating systems executive, communications, application programs, operator interface, and control description logic.
  .2 Software to include any "firmware" or instructions which are programmed into ROM or other non volatile memory.
  .3 All initial programming of all MCU's and the entire MCU system shall be done by this contractor.

.2 Program and Data Storage:
  .1 All executive programs will be resident in read only memory or other memory or other nonvolatile media. Site configuration data will also be maintained in a nonvolatile manner.
  .2 Control Description Logic (CDL) and operating data, such as setpoints, operating constants, and alarm limits must be maintained in a battery-backed Random Access Memory (RAM) and hence modifiable by the operator.
  .3 Programming Languages:
    .1 All software shall be programmed in a GENERAL CONTROL type LANGUAGE.
    .2 Software to be structured in modular fashion to permit simple restructuring of program modules if future software modifications or additions are made.
  .4 Operator Interface:
    .1 The MCU must be capable of performing the operating and control functions as required.
    .2 Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control.
      .1 Alarm Management:
        .1 Processing and Messages
        .2 Operator Commands
        .3 Reports
        .4 Displays

.3 Pseudo or Calculated Points:
  .1 The controller software shall have the capability to define and calculate a pseudo point from other values/status of the controller. When a current pseudo-point value is derived, normal alarm checks can be performed or the value used to totalize. In this way, fuel or other energy usage can be totalized. In calculating the pseudo point, the software shall have access to any value or status in the controller.

.4 Control Description Logic (CDL):
  .1 The contractor shall provide the capability of generating on-line, the control logic (CDL) specific to each site in which the controller(s) is to be installed. CDL's shall be software based and be programmed into battery backed RAM and backed up by discs or tape(s). Departmental Representative shall have access to these in order to create new ones and be able to integrate these into the sequence of operation descriptions on the MCU or OWS.

.2 Control description logic shall be written in a high level language that allows logic and interlocking programs to be written simply and efficiently. Parameters entered into the system such as setpoints are to be used to determine the operation. The operator shall, at his discretion, be able to alter the operating parameters on-line from the MCU or to tune a control loop.

.3 Any change to the CDL or interlock program be performed on-line.

.4 Control logic will have access to values or status of all points available to the controller including global or common values, allowing cascading or interlocking control.

.5 Energy Optimization routines such as Enthalpy Control, Supply Temperature reset etc. to be local LCU and MCU functions and form part of the CDL.

.5 Pre-Tested Control Algorithms:

.1 The MCU panels shall have the ability to perform the following pre-tested control algorithms:

.1 Two Position Control

.2 Proportional Control

.3 Proportional plus Integral Control

.4 Proportional, Integral, plus Derivative Control

.5 Automatic Control Loop Tuning

.6 Equipment Cycling Protection:

.1 Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

.7 Heavy Equipment Delays:

.1 The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.8 Powerfail Motor Restart:

.1 Upon the resumption of normal power, as determined by the emergency power transfer switches, the MCU panel shall analyse the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

.9 Energy Management Programs:

.1 MCU Panels shall have the ability to perform any or all of the following energy management routines:

.1 Time of Day Scheduling

.2 Calendar Based Scheduling

.3 Holiday Scheduling

.4 Temporary Schedule Overrides

.5 Optimal Start

.6 Optimal Stop

.7 Night Setback Control

.8 Enthalpy Switch over (Economizer)

.9 Peak Demand Limiting

.10 Temperature Compensated Load Rolling

.11 Fan Speed/CFM Control

.12 Heating/Cooling Interlock

.13 Cold Deck Reset
.14 Hot Deck Reset
.15 Hot Water Reset
.16 Night Purge

.2 All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

.10 Totalization:

.1 Runtime Totalization:

.1 MCU panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

.2 The Totalization routine shall have a sampling resolution of one minute or less.

.3 The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

.2 Analog/Pulse Totalization:

.1 MCU panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

.2 Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons. etc.).

.3 The Totalization routine shall have a sampling resolution of one minute or less.

.4 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

.3 Event Totalization:

.1 MCU panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

.2 The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

.3 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

.2 All related work defined under Division 25.

1.2 DESCRIPTION

.1 The Laboratory Control System (LCS) shall be fully integrated to the HVAC Instrumentation and Controls System to maintain laboratory room supply and exhaust airflows, room ventilation rates, room static pressurization, room ambient temperatures & humidity's and the laboratory exhaust system functionality as specified herein.

.2 The LCS shall include all laboratory room supply and exhaust airflow terminals, fume hood airflow terminals, air terminal actuators, sensors, associated instrumentation and the control units and associated interconnecting wiring. Any and all associated components required to implement a fully functioning and integrated system as specified herein shall also be provided. System verification and other documentation as specified under the Sections referenced herein shall also be included.

.3 All LCS data shall be capable of being accessed by authorized persons via the facility HVAC control system as well as via the Intranet using standard web browsers to obtain LCS data in graphical form as well as in specific user defined and configured LCS summary and status reports.

Part 2 Products

2.1 LABORATORY CONTROL SYSTEM

.1 General:

  .1 Use new products that the manufacturer is currently manufacturing and that have been installed in similar installations. Do not use this installation as a product test site unless explicitly approved in writing by Departmental Representative or Departmental Representative's representative. Spare parts shall be available for at least five years after completion of this contract.

.2 Laboratory Controllers:

  .1 VAV Fume Hood Face Velocity Controller (FHC)

    .1 Furnish and install a UL 916 listed individual VAV fume hood controller for each VAV fume hood which shall maintain the required average face velocity at the setpoint independently of the sash position. Documentation verifying the UL 916 Listing for the fume hood controller shall be included in any proposal as well as the submittal. Also, furnish and install sash sensors on each fume hood to indicate the position of all fume hood sashes to the respective fume hood controller. Sash sensors shall provide an input signal to the fume hood controller that is linearly proportional to within one half inch of the actual sash position. All sash sensors shall be highly corrosion resistant. Sash sensor operational life shall allow a minimum of 1 million full sash travel cycles.

.2 The FHC velocity control process shall maintain the average fume hood face velocity at the desired setpoint using a proportional, integral and derivative (PID) closed loop control algorithm. The fume hood face velocity control process shall be as follows:

.1 The fume hood controller shall continually determine the fume hood's total open area by monitoring the fume hood sash position(s) by the sash sensor(s) as well as taking account of any fume hood fixed open areas and the bypass opening(s).

.2 The fume hood controller shall calculate the required fume hood exhaust airflow necessary to maintain the average face velocity setpoint over the total open area. The controller shall continuously perform the above exhaust airflow control calculations ten times per second to ensure detection of and a maximum of 1 second response to any change in sash position.

.3 The fume hood controller shall control the fume hood exhaust airflow at the rate necessary to maintain the average face velocity setpoint. The fume hood controller shall ensure that the required fume hood exhaust to maintain the average face velocity setpoint is always maintained independently of any variations in exhaust system static pressure or any laboratory room conditions such as the ventilation airflow or room static pressure that could otherwise affect the fume hood exhaust airflow.

.3 The fume hood face velocity control process shall accommodate the required fume hood maximum to minimum exhaust airflow rate. The fume hood controller shall always maintain the required minimum fume hood exhaust airflow recommended by laboratory safety standards whenever the total fume hood open area requires less than the calculated fume hood exhaust airflow necessary to maintain the average face velocity set point. The fume hood controller shall also be capable of limiting the maximum fume hood exhaust airflow regardless of the extent of the sash opening.

.4 The fume hood controller shall also interface to an Operator Display Panel (ODP) at the designated measurement location on the front of the fume hood as shown on the project plans. The ODP shall provide a continuous digital display of average fume hood face velocity whenever the fume hood sash open area requires more than the minimum fume hood exhaust airflow. The fume hood face velocity display shall be the true average face velocity as calculated by the fume hood controller based upon actual measured fume hood exhaust airflow and the total fume hood total open area. The Operator Display Panel shall have the ability to blank out display of face velocity based on Departmental Representative’s preference.

.5 The ODP shall also include separate colored LED strip lights that shall illuminate to indicate fume hood operational status as:
  .1 Green for proper face velocity or flow.
  .2 Yellow for marginal face velocity or flow.
  .3 Red for alarm conditions such as low face velocity, general failure or emergency purge

.6 The ODP shall also sound an audible alarm device in response to face velocity alarm conditions and the ODP digital display shall change to "LOW FACE VELOCITY" or "HIGH FACE VELOCITY" appropriate to the alarm condition. A SILENCE pushbutton on the ODP shall allow the user to silence the audible alarm which shall then remain silent until a subsequent alarm occurs.

.7 The ODP shall also provide an EMERGENCY PURGE pushbutton which shall enable a user to increase fume hood exhaust airflow to the maximum amount for a designated period of time as required by laboratory safety standards. After the designated time has expired the fume hood exhaust shall automatically reset to a lower, but still elevated level to prevent excessive demand on the exhaust system. The emergency purge mode of operation shall also be able to be cancelled at any time by depressing the emergency purge button a second time. The ODP shall sound its audible alarm device whenever the emergency purge mode of operation is activated. The silence pushbutton on the ODP shall also allow the user to silence the audible alarm which shall then remain silent until either the emergency purge operational mode is again activated or a face velocity alarm occurs.

.8 The ODP shall also provide an audible SASH open ALERT feature that can be implemented to caution users whenever the fume hood sash opening exceeds a predetermined amount. The audible alert shall consists of one minute repeating cycles of a series of quick 'chirps' that continues until the sash opening is reduced to an allowable amount. There shall be two sash alert opening settings, based on whether hood is in use or unattended.

.9 The ODP shall provide audible and visual indication whenever supervisory signal is lost from a fume hood sash sensor or the flow input transmitter, by turning on the Red light and the audible alarm device. .

.10 All fume hood control and ODP display and operational parameters shall be established and be changeable only by authorized personnel using a portable operator's terminal. These operational parameters shall include:
  .1 Fume hood average face velocity setpoint.
  .2 Fume hood minimum & maximum exhaust airflow.
  .3 Face velocity high and low alarm limits and associated alarm time delay to avoid transient alarms.
  .4 Face velocity high and low warning limits.
  .5 Emergency purge time periods and exhaust levels.
  .6 Allowable maximum sash opening associated with the sash alert feature.

.11 The portable operator’s terminal shall plug into the ODP as well as into the laboratory room controller. In addition, all laboratory fume hood and laboratory room control parameters along with all other facility control and monitoring functions shall be accessible to authorized personnel from designated terminals on the EMCS control and monitoring network.

.12 Momentary or extended losses of power shall not change or affect any VAV fume hood control setpoints, operational parameters or stored data. Upon resumption of power after a power failure, fume hood controllers shall resume full normal operation exactly as before the power failure and without any need for manual intervention. Upon a power failure or operational failure within the fume hood controller, the fume hood exhaust air terminal shall be automatically positioned to the fully open (failsafe) position as required by laboratory safety standards and defined herein.

.13 Coordinate sash sensor requirements with the fume hood size and sash configuration defined in the Lab Furnishings documents.

2.2 VAV GENERAL LAB ROOM CONTROLLERS (LCU)

.1 Laboratory room controllers shall provide closed loop pressure independent control of all laboratory room ventilation and ambient requirements. The laboratory room controller shall continuously monitor all the supply and auxiliary exhaust airflow devices including VAV fume hoods in the room.

.2 Pressure control algorithm shall control supply and exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. The offset shall be field adjustable and represents the volume of air which will enter (or exit) the room from the corridor or adjacent spaces.

.3 Unless specifically indicated within, Sequence of Operation, volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall provide documentation that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.

.4 Room ambient control (temperature, humidity etc.) and any other room control functions (lighting, IAQ etc.) shall be maintained by the controller as indicated in The Sequence of Operation.

.5 All laboratory room controllers (LCU’s) shall include all inputs and control outputs necessary to perform the specified control sequences. Each laboratory room controller shall operate as a stand alone unit, performing its specified control responsibilities independently. All input point and control output point databases as well as the control programs shall be stored in non-volatile EEPROM, EPROM and PROM memory, or a minimum of 100-hour battery backup shall be provided.

.6 Laboratory and Pressurized Room Controllers shall have available a SECURE MODE of operation, in which changes to any control parameter can only be made from designated terminals on EMCS by authorized personnel, and not through the man-machine interface port.

.7 Momentary or extended losses of power shall not change or affect any laboratory room controller setpoints or stored data. Upon resumption of power the controller shall resume full normal operation exactly as before without any need for manual intervention. Upon a power failure or operational failure within the controller, the air terminal shall automatically be positioned to the predetermined fully open or fully closed (failsafe) position as indicated on the air terminal schedules in the project plans.

.8 All laboratory room control units (LCU's) shall include the ability to accept a minimum of two dry contact closure inputs from an auxiliary source into the room control sequence for such purposes as occupied/unoccupied ventilation changeover, emergency mode sequences, etc.

.9 All laboratory room controllers shall provide a general alarm output that may be used for auxiliary signaling or notification.

2.3 LABORATORY VAV AIR TERMINALS (GENERAL EXHAUST OR FUME HOOD EXHAUST)

.1 Single Blade Damper are the only acceptable per the following requirements: Single Blade Damper - Closed Loop Control:

.1 Provide industrial grade Terminal Units with construction, leakage, and performance as stated within. Commercial grade terminal units are not acceptable. Units not conforming to all construction and performance criteria listed herein will be rejected.

.2 Laboratory Terminals shall have a single blade damper for airflow adjustment and shall provide the individual airflow capacities indicated in the project airflow schedules. Terminal airflow shall be pressure independently controlled using actual independent airflow measurement feedback as an integral part of a closed loop control process.

.3 Minimum airflow sensor measurement accuracy shall be +/- 5% of actual airflow over the entire design airflow range of each air terminal. Airflow measurement accuracy substantiation by a qualified independent test agency shall be available upon request.

.4 Airflow transmitter shall be factory mounted on the terminal and shall include the necessary signal conditioning/transmitter instrumentation to provide an output proportional to the velocity pressure. Transmitter shall have an accuracy of at least +/- 0.5% of the transmitter range and a drift no greater than 0.5% full scale/year Transmitter ranges shall not exceed 0 to 1.00 Inches W.C. High and low limits shall be fully adjustable. Transmitters not meeting the drift requirements shall be provided with an auto-zero solenoid that connects to the air velocity pressure transducer's inlet ports for enabling automatic periodic re-calibration to ensure drift-free airflow measurement. Automatic re-calibration shall occur at a minimum every 24 hours without airflow disruption to the space.

.5 All single blade damper air terminals shall have a wide open pressure drop less than 0.25"wc at airflow equivalent to 2000 fpm inlet duct velocity.

.6 All fume hood exhaust terminals shall be constructed of minimum 20 gauge, 316L stainless steel. (As an option fume hood exhaust terminals may also be coated with Teflon.) Damper shafts shall be ½" diameter stainless steel with self-lubricating Teflon bushings and with external indication of the damper position. Fume hood exhaust terminals shall be provided with an orifice ring type of airflow sensor located upstream of the damper. Airflow sensing techniques that are likely to become inoperative due to accumulation of particulate or chemical deposits or which can catch debris and obstruct exhaust airflow shall not be acceptable for fume hood exhaust applications. Unacceptable airflow measurement sensors for fume hood exhaust air terminals include pitot tubes, vortex shedders, thermal anemometers and other devices that protrude into the center of the exhaust air stream.

.7 Discharge and radiated sound power level data shall be provided for each different size and type of air terminal as part of the submittal documentation. Sound power data shall be obtained in accordance with ANSI/ASHRAE 130-1995 Standard Methods of Testing for Rating Ducted Air Terminal Units. All sound data shall be obtained by a qualified, accredited and ARI approved testing laboratory.

.2 Laboratory Terminal Unit Electric Actuators

.1 General: Provide high-speed electronic actuators for all supply and exhaust type terminals serving spaces with VAV fume hoods. All other terminals shall be provided with standard electronic actuators as specified herein. All actuators shall be factory mounted on terminals.

.2 For high-speed actuators, the flow response time from 0 to 90% flow shall be no greater than 1 second under normal conditions when used with either a terminal box single blade damper or venturi air valve.

.3 All actuators shall be provided with a manual override feature allowing the end user to stroke the damper to either the full open or full closed position. Actuators shall be capable of either floating control or analog (0-10Vdc, 4-20mA) control, as needed by the Laboratory application.

.4 Fail-safe position shall be as indicated in sequence of operation/control drawings specified herein. Failure mode shall be field selectable via dipswitches.

Part 3 Execution

3.1 EXAMINATION

.1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/Departmental Representative for resolution before rough-in work is started.

3.2 PROTECTION

.1 The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.

.2 The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted.

3.3 COORDINATION

.1 Site
.1 Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.
.2 If the contractor deviates from the job schedule and installs work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
.3 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
.4 Submittals. Refer to the "Submittals" article in Part 1 of this specification for requirements.

.2 Installation
.1 The controls contractor shall be responsible for installing all work defined herein including controllers, sensors, damper actuators, fume hood sash sensors and fume hood operator display panels. This contractor shall install and terminate all low voltage LACS wiring including wiring between each controller and between each controller and all control and sensing devices including laboratory air terminals and reheat valves.
.2 The Division 26 Contractor shall provide 120 volt power in the laboratory ceiling spaces for connection to the laboratory control system equipment or where indicated on Division 26 drawings. It shall be the responsibility of this contractor to provide 24 VAC power where required by the LACS and associated control devices.
.3 Air Terminals, Reheat Coils and Control Valves
.1 LACS contractor shall furnish all laboratory air terminals, reheat coils (if separate from the air terminal) and control valves to the Div 23 contractor for installation per Part 1 "Products Furnished but Not Installed". Div XX contractor shall provide necessary ductwork/piping transitions as required for mounting equipment provided by the LACS contractor.
.2 Actuators shall be mounted on the same side of air terminals as coil connections to ensure service access
.3 Access door shall be provided at inlet side of coil.
.4 Fume Hood Controls
.1 Coordinate all requirements with the fume hood manufacturer
.2 Furnish templates to the fume hood manufacturer for any devices requiring fume hood mounting. Fume hood manufacturer shall provide necessary cut outs with blank cover plates.
.3 Verify any sash sensor requirements with the fume hood manufacturer based on fume hood size, sash configuration and installation requirements for each device.

.4 LACS contractor shall field install, mount and wired required hood mounted devices.

3.4 LACS SYSTEM CHECKOUT AND TESTING

.1 System startup shall be provided by factory certified and trained employees of the LACS manufacturer. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Departmental Representative’s representative is notified of the system demonstration. Start up shall include the following tasks:
  .1 Determine when the HVAC equipment and each room is ready for ventilation system operational testing.
  .2 Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
  .3 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
  .4 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules.
  .5 Alarms and Interlocks:
    .1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    .2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
    .3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
  .6 Set up all laboratory room and fume hood controllers and verify that all controlled parameters are being maintained at the required setpoint and that all associated operational aspects including measurement accuracies, alarm criteria, high-low limits, time delays, etc. are functioning in accord with the specified performance. The Testing Adjusting and Balancing (TAB) agent shall verify that all airflows are within the specified requirements and any departure from the specified performance shall be corrected and verified by the LACS to ensure all aspects of the control system are in full conformance with these specifications. The setup and verification process shall cover:
    .1 Fume hood face velocity and/or fume hood exhaust airflow rate control.
    .2 Fume hood high and low alarms.
    .3 Room supply and exhaust airflows and the room ventilation rate control.
    .4 Room static pressurization control and associated operational criteria.
    .5 Room ambient temperature control.
    .6 Room/zone humidity control.
    .7 Room emergency control sequences.
    .8 Laboratory facility centralized exhaust system static pressure, exhaust stack velocity and associated exhaust system functionality.

.2 All operational aspects of the LACS performance shall be formally recorded when verified and a copy of the recorded data shall be provided to the Departmental Representative as part of the as-built documentation.

3.5 BUILDING AUTOMATION SYSTEM INTERFACE

.1 All points as indicated on drawing schematics shall be provided to and from the EMCS..

.2 Information may be communicated by means of protocol translators or by seamless LAN connections.

3.8 SEQUENCE OF OPERATION

.1 VAV Fume Hood

.1 General Description - Reference Control Drawing(s) H-501 and H-502.

.1 This control sequence applies to VAV fume hoods in a manifold fume hood exhaust system to maintain the average fume hood face velocity at the desired setting.

.2 This sequence uses sash alarms and up to three face velocity setpoints to limit the air entering the hood.

.3 Each fume hood has an individual exhaust terminal connected to a central fan.

.2 Steady State Operation – Normal

.1 The fume hood controller shall continually determine the fume hood's total open area by monitoring the fume hood sash position(s) by the sash sensor(s) as well as taking account of any fume hood fixed open areas and the bypass opening(s).

.2 The fume hood controller shall calculate the required fume hood exhaust airflow necessary to maintain the average face velocity setpoint over the total open area. The controller shall continuously perform the above exhaust airflow control calculations ten times per second to ensure detection of and a maximum of 1-second response to any change in sash position.

.3 The fume hood controller shall control the fume hood exhaust airflow at the rate necessary to maintain the average face velocity setpoint. The fume hood controller shall ensure that the required fume hood exhaust to maintain the average face velocity setpoint is always maintained independently of any variations in exhaust system static pressure or any laboratory room conditions such as the ventilation airflow or room static pressure that could otherwise affect the fume hood exhaust airflow.

.4 The controller shall maintain a minimum exhaust flow regardless of sash position as recommended by the fume hood manufacturer, safety guidelines or as indicated on the air terminal schedules.

.3 Sash Alert Alarm

.1 Sash alert alarm shall be provided for independently configurable attended (occupied) and unattended (unoccupied) modes.

.2 When the sash opens above a preset limit (adjustable), the ODP horn shall beep six times every minute until the sash is lowered below the alarm limit.

.3 The sash alert alarm point shall be available to the BMS.

.4 The occupied/unoccupied mode for the fume hood sash alert setting shall be the same as that being used by its associated lab space.

.4 Emergency Mode

.1 The ODP shall also provide an EMERGENCY PURGE pushbutton, which shall enable the user to increase fume hood exhaust airflow to maximum for a designated period of time. After the designated time has expired the fume hood exhaust shall automatically reset to a lower (but elevated) level to prevent excessive demand on the exhaust system. The emergency purge shall also be able to be cancelled at any time by depressing the emergency purge button a second time. The ODP shall sound an audible alarm device whenever the emergency purge mode of operation is activated. The silence pushbutton on the ODP shall allow the user to silence the audible alarm device, which shall then remain silent until either the emergency purge operational mode is again activated, or an exhaust airflow alarm occurs.

.2 The fume hood controller shall also be capable of an Emergency Mode based on input from the BAS and shall operate the same as indicated by the manual command by the ODP.

.5 Start-up Mode

.1 During the start-up mode the controller will be fully functional, but the local audible alarm will be disabled. This mode allows the controller to be started up without nuisance alarms being sounded at hood.

.6 Fail-safe Operation

.1 Momentary or extended losses of power shall not change or affect any fume hood controller setpoints or stored data. Upon resumption of power the fume hood controller shall resume full normal operation exactly as before without any need for manual intervention. Upon a power failure or operational failure within the fume hood controller, the fume hood exhaust air terminal shall be automatically positioned to the fully open (failsafe) position.

.2 VAV General Laboratory – Airflow Tracking

.1 General Description – Reference Control Drawing(s) – H-501 and H-502.

.1 This control sequence applies to general laboratory spaces and support spaces with supply and exhaust laboratory airflow terminal devices for providing flow tracking pressurization control.

.2 Each room consists of VAV dual duct supply and exhaust laboratory air terminal, fume hoods or multiple combinations.

.2 Steady State Operation – Normal

.1 Steady state operation mode is designed to be around 6 air changes per hour as set through the balance of total exhaust in the room.

.2 Ventilation control (ACH):

.1 The laboratory room controller (LCU) shall continuously totalize all room exhaust airflows as the total room exhaust airflow. The laboratory room controller shall continuously calculate the difference between the total room exhaust airflow and the room exhaust airflow required to maintain the room air ventilation rate (air change per hour) as listed in the laboratory room schedule in the plans. Whenever the total room exhaust airflow is less than the room exhaust airflow required to maintain the room minimum ventilation rate, the laboratory room controller shall increase the room general exhaust airflow until the total room exhaust airflow equals the required room exhaust airflow.

.2 Whenever total room exhaust airflow is greater than the required room exhaust airflow, the laboratory room controller shall decrease the room general exhaust airflow until the total room exhaust airflow equals the required room exhaust airflow or the general exhaust airflow is reduced to its minimum value.

.3 These sequences shall be able to be customized on site by adjusting parameters such as control loop algorithm gains, temperature setpoint, alarm limits, airflow differential setpoint, and pressurization mode.

.3 Pressurization control:

.1 The laboratory room controller shall continuously totalize all room exhaust airflows including fume hood exhausts, miscellaneous exhausts such as bench canopies and the room general exhaust, as applicable to individual rooms, as the total room exhaust airflow. The laboratory room controller shall also continuously measure the room supply airflow.

.2 The laboratory room controller shall continuously control the room supply airflow at value necessary to maintain the predetermined (adjustable) airflow tracking differential between the total room exhaust airflow and the room supply airflow as listed in the room airflow schedule on the project plans and/or determined by Test and Balance . For negatively pressurized rooms the room supply airflow shall always be maintained at a lower value than the total room exhaust airflow by the airflow tracking differential cfm (l/s). For positively pressurized rooms the room supply airflow shall always be maintained at a higher value than the total room exhaust airflow by the airflow tracking differential cfm (l/s).

.4 Temperature control:

.1 The laboratory room controller shall continuously measure the temperature in the room by means of the room temperature sensor. The laboratory room controller shall maintain the room temperature at its adjustable setpoint by modulating the cold deck and hot deck dampers. The room temperature control action shall utilize a proportional, integral and derivative (PID) closed loop control algorithm.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

.1 Provide Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a Standard NEMA Design B induction motor. The drive manufacturer shall supply the drive and all necessary controls as herein specified. Third party fabrications of AFD Control Panels are not acceptable.

.2 Qualifications:
- .1 Acceptable Manufacturers:
  - .1 ABB ACH550 Series
  - .2 Siemens Industrial Series
  - .3 Danfoss Industrial Series

1.2 SUBMITTALS

.1 Submittals shall include the following information:
- .1 Outline dimensions, conduit entry locations and weight.
- .2 Customer connection and power wiring diagrams.
- .3 Complete technical product description include a complete list of options provided
- .4 Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
  - .1 The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519. All AFD's shall include a minimum of 5% impedance reactors.

1.3 MANUFACTURE ITEMS

.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

Part 2 Products

2.1 VARIABLE FREQUENCY DRIVES

.1 VFD line voltage tolerance to operate from +30% and -35% of 600VAC nominal voltage without tripping.

.2 VFD Enclosure shall be NEMA 1 and UL listed as a plenum rated.

.3 All VFDs shall have the following standard features:

.1 All VFDs shall have the same removable HVAC keypad, regardless of voltage and horsepower rating. The keypad shall be capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

.2 The keypad shall include Hand-Off-Auto buttons; Fault Reset and a Help Button to include “on-line” assistance for programming and troubleshooting.

.3 There shall be a built-in real time clock in the VFD keypad.

.4 The VFD shall be capable of starting into a coasting load (either rotation)

.5 The VFD shall have the ability to automatically restart after a fault. The number of attempts and time delay between attempts shall be programmable.

.6 The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

.7 The VFD shall have an integral 5% impedance input line choke/reactor to reduce the harmonics to the power line and to add protection from AC line transients.

.8 The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV’s (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

.4 All VFDs to have the following standard features:

.1 Two (2) programmable analog inputs: 0/4-20mA or 0/2-10VDC signals.

.2 Two (2) programmable analog outputs (0/4-20mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

.3 Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices.

.4 Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 Amps at 250VAC; open collector outputs are not acceptable.

.5 The Keypad shall include a backlit LCD display. The display shall be in complete English (or Multilingual) words for programming and fault diagnostics. The keypad shall utilize the following assistants:

.6 Start-up assistants.

.7 Parameter assistants

.8 Maintenance assistant

.9 Troubleshooting assistant

.10 All applicable operating values shall be capable of being displayed in Departmental Representativeing (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete words: Output Frequency; Motor Speed (RPM, %, or Departmental Representativeing units); Motor Current; Calculated Motor Torque; Calculated Motor Power (kW); DC Bus Voltage; Output Voltage.

.11 The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

.12 EMI/RFI filters. All VFDs shall include EMI/RFI filters. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

.5 OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be CSA or ULC approved and listed by the drive manufacturer as a complete assembly and carry a CSA or ULC label.

.1 A complete factory wired and tested E-Bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.

.2 Door interlocked padlock-able circuit breaker that will disconnect all input power from the drive and all internally mounted options.

.3 Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. The drive / E-bypass shall provide single-phase motor protection in both the VFD and bypass modes.
The following operators shall be provided:

.1 Bypass Hand-Off-Auto;
.2 Drive mode selector;
.3 Bypass mode selector;
.4 Bypass fault reset;
.5 The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.;
.6 Power-on (Ready);
.7 Run enable (safeties) open;
.8 Drive mode select damper opening;
.9 Bypass mode selected;
.10 Drive running;
.11 Bypass running;
.12 Drive fault;
.13 Bypass fault;
.14 Bypass H-O-A mode;
.15 Automatic transfer to bypass selected;
.16 Safety open;
.17 Damper opening;
.18 Damper end-switch made;
.19 The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

.6 Controls:
  .1 The VSD manufacturers shall provide terminals for connections to the EMCS. The connections shall include start/stop, status, alarm and speed adjustment.
  .2 The VSD manufacturer shall provide open protocol and terminals for connection to the EMCS by Controls Division, for transfer of data from the VSD to the EMCS. The communication protocol shall be either BACnet or LON works.

Part 3 Execution

3.1 START-UP & COMMISSIONING

1. Certified factory start-up shall be provided for each drive by a factory authorized Technician. A certified start-up/commissioning form shall be filled out for each drive with a copy provided to the Departmental Representative, and a copy kept on file at the manufacturer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section covers items common to Sections of Division 26. This Section also supplements requirements of Division 1.

1.2 REFERENCES

.1 American Society for Testing and Materials (ASTM International) latest edition of the following:
  - .1 ASTM E814, Standard Test Method for Fire Tests of Penetration Firestop Systems.

.2 Canadian Standards Association (CSA International) latest edition of the following:
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2 CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.3 Institute of Electrical and Electronics (IEEE) latest edition of the following:
  - .1 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms.

.4 National Research Council of Canada (NRCC) latest edition of the follow:
  - .1 NBC, National Building Code.

1.3 DEFINITIONS

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.4 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.5 SUBMITTALS

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

.2 Submit for review single line electrical diagrams in glazed frames and locate as indicated.
  - .1 Electrical distribution system in main electrical room.

.3 Submit for review fire alarm riser diagram, plan and zoning of building in glazed frames at fire alarm control panel.

.4 Shop drawings:
- .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, conduit piping and other items that must be shown to ensure coordinated installation.
- .2 Identify on wiring diagrams, circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .3 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .5 If changes are required, notify Departmental Representative of these changes before they are made.

.5 Quality Control: in accordance with Section 01 45 00 – Quality Control.
- .1 Provide CSA certified equipment and material.
- .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
- .3 Submit test results of installed electrical systems and instrumentation.
- .4 Permits and fees: in accordance with General Conditions of contract.
- .5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

.6 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within three (3) days of review, verifying compliance of Work and electrical system and instrumentation testing , as described in PART 3 - FIELD QUALITY CONTROL.

1.6 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for incorporation into operation and maintenance manual specified in Section 01 78 00 – Closeout Submittals.

.2 Include in operation and maintenance data:
- .1 Names and addresses of local suppliers for items included in maintenance manuals.
- .2 Copy of reviewed shop drawings.
- .3 Details of design elements, construction requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion of feature of installation.
- .4 Technical data and product data, supplemented by bulletins, component illustrations, exploded view, technical descriptions of items and parts lists. Advertising or sales literature not acceptable.
- .5 Wiring and schematic diagrams and performance curves.

1.7 MAINTENANCE MATERIALS

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

1.8 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00 – Quality Control.

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings:
  - .1 In accordance with Section 01 32 00 – Construction Progress Documentation.
  - .2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, and/or in appropriate NMS Section, schedule site visits, to review Work, at stages listed.
    - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
    - .2 Twice during progress of Work at 25% and 60% complete.
    - .3 Upon completion of Work, after cleaning is carried out.

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 – Health & Safety Requirements.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 30 days after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.10 SYSTEM STARTUP

.1 Instruct facility's operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service representative to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

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

1.11 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:
  .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  .3 Safety precautions.
  .4 Procedures to be followed in event of equipment failure.
  .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.12 ELECTRICAL DRAWINGS

.1 Drawings are diagrammatic.

.2 Obtain accurate dimensions from architectural and equipment layout drawings.

1.13 PERMITS, FEES AND INSPECTION

.1 Obtain an electrical work permit and pay associated fees.

.2 Submit to Electrical Inspection Department and Power Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

.3 Departmental Representative will provide drawings, specifications required by Electrical Inspection Department and Power Supply Authority at no cost.

.4 Notify Departmental Representative of changes required by the Inspection Department prior to making changes.

.5 Furnish Certificates of Acceptance from Electrical Inspection Department on completion of work to Departmental Representative.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Provide material and equipment in accordance with Section 01 61 00 – Common Product Requirements.

.2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction, inspection authorities before delivery to site and submit such approval as described and in PART 1 - Submittals.

.3 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

.2 Division 26 responsibility is as follows:
- .1 Supply and installation of breakers and/or switches.
- .2 Supply and installation of power feeder (conduit and wire) from panel to starter, from starter to disconnect switch and from disconnect switch to motor.
- .3 Supply and installation of starters complete with motor protection unless noted otherwise.
- .4 Supply and installation of disconnect switches at motors unless noted otherwise on mechanical drawings.
- .5 Installation and wiring of line voltage thermostats and PE switches where directly control 120V fractional horsepower motors.
- .6 Supply and installation of 120V power feeders to mechanical equipment such as time clocks and control panels.

.3 Control wiring and conduit is by Division 25 unless noted otherwise on electrical drawings.

2.3 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of authority having jurisdiction, inspection authorities and Departmental Representative.

.2 Decal signs, minimum size 178mm x 254mm.

2.4 WIRING TERMINATIONS

.1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.5 IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: Lamicoid 1/8" thick plastic engraving sheet, black matte finish face with white core for normal power, and white matte finish face with red core for emergency power and life safety system including fire alarm, lettering accurately aligned and engraved into core, mechanically attached with self tapping screws.

.1 Sizes as follows:

NAMEPLATE SIZES			
Size 1	9mm x 50mm	1 line	3mm high letters
Size 2	12mm x 51mm	1 line	4.5mm high letters
Size 3	12mm x 51mm	2 lines	3.175mm high letters
Size 4	19mm x 76mm	1 line	8mm high letters
Size 5	19.mm x 76mm	2 lines	4.5mm high letters
Size 6	25mm x 102mm	1 line	12mm high letters
Size 7	25mm x 102mm	2 lines	6mm high letters

.2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.

.2 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.

.3 Allow for minimum of twenty-five (25) letters per nameplate and label.

.4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.5 Identify equipment with Size 3 nameplates engraved as directed by terminology used on drawings and in specifications.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Transformers: indicate capacity, primary and secondary voltages.

2.6 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

WIRING COLOUR CODING	
Phase A	Red
Phase B	Black
Phase C	Blue
Neutral	White/Grey

Ground	Green
Bond	Green
Isolated Ground	Green with Yellow Stripe

.4 Use colour coded wires in communication cables, matched throughout system.

2.7 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 6 foot intervals.

.3 Colours: to match facilities existing colour coding scheme. 25mm wide prime colour and 9.05mm wide auxiliary colour.

.4 Coverplates for boxes containing branch circuits are to have each branch circuit number neatly identified on the coverplate with felt marker pen.

2.8 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish.
  - .2 Paint indoor electrical equipment and enclosures “light gray” finish.

2.9 ACCEPTANCE OF ALTERNATIVE MATERIALS

.1 Acceptable Materials:
  - .1 Where materials are specified by the trade name, refer to the “Special Instructions to Tenderers” form for procedure to be followed in applying for approval of alternatives.

2.10 HOUSE KEEPING PADS

.1 Co-ordinate with the General Contractor for the provision of housekeeping pads under floor mounted equipment.

.2 Provide concrete housekeeping pads for all switchboards, motor control centres, transformers and all other free-standing electrical equipment. Pads to be a minimum of 6” larger than the outside dimensions of the equipment they support, and not less than 4” thick. Housekeeping pads are to have chamfered edges.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 and NBC.

3.2 NAMEPLATES AND LABELS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.
  .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.

.2 Do not install outlets back-to-back in wall; allow minimum 152mm horizontal clearance between boxes.

.3 Outlets that are installed within 1.5m of wash basins complete with drainpipe shall be protected by a ground fault circuit interrupter, Class A type.

.4 Change location of outlets at no extra cost or credit, providing distance does not exceed 3m and information is given before installation.

.5 Locate light switches on latch side of doors.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise:
  .1 Local switches: 1220mm.
  .2 Wall receptacles:

.1 General: 457mm.
.2 Above top of continuous baseboard heater: 203mm.
.3 Above top of counters or counter splash backs: 178mm.
.4 In mechanical rooms: 1220mm.

.3 Panelboards: as required by Code or as indicated.
.4 Voice and data outlets: 457mm.

3.6 FIELD QUALITY CONTROL

.1 Load Balance:
.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
.3 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Conduct and pay for following tests in accordance with Section 01 45 00 – Quality Control:
.1 Power distribution system including phasing, voltage, grounding and load balancing.
.2 Circuits originating from branch distribution panels.
.3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
.4 Insulation resistance testing:
.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.3 Check resistance to ground before energizing.
.4 Replace conductors as required.

.3 Carry out tests in presence of the Departmental Representative.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

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

3.7 FIREPROOFING

.1 Seal any penetrations for conduits and/or cables that pass through floors and fire rated walls with CSA approved material. Fire ratings of walls/floors are to be maintained utilizing a proper firestop system. Firestop systems are to be tested to ASTM E814 criteria.

.2 Caulking shall not be used as a firestopping method for PVC conduits.

.3 Submit firestopping material shop drawings for review by Departmental Representative.

.4 Acceptable manufacturer:
- .1 3M
- .2 Hiliti
- .3 Nelson

3.8 AS-BUILT RECORDS

.1 General: To be read in conjunction with Section 01 78 00 – Closeout Submittals.

.2 Site Records:
- .1 Obtain sets of white prints and mark thereon all changes as work progresses and as changes occur. Incorporate all information issued in Addenda, Site Instructions, Change Orders and all changes in actual installation as a result of site conditions and coordination.

.3 As-Built Drawings:
- .1 Prior to start of testing, balancing and adjusting, finalize production of as-built drawings.
- .2 Identify each drawing in lower right hand corner in letters at least 12mm high as follows: AS-BUILT DRAWINGS (This drawing has been revised to show electrical systems as installed) (Signature of Contractor) (Date).
- .3 Submit to the Project Manager for approval and make all corrections as directed.
- .4 Testing, balancing and adjusting to be performed using as-built drawings.
- .5 Hand over 100 % updated CAD files and one hard copy of as-built drawings with Operating and Maintenance Manuals.

.4 At the 95% project completion stage, based on Progress Claim, Provide one (1) set of up-to-date prints of "As-Built" drawings, to the Departmental Representative for review. Progress claim will not be released until this step has been completed.

3.9 CLEANING

.1 Cleaning: in accordance with Section 01 74 11 – Cleaning.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

.4 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt.

.5 Remove construction materials from wiring devices, coverplates, outlets, cabinets, enclosures, tubs, etc…

3.10 COOPERATION

.1 Co-operate and investigate with other trades to make maximum use of spaces. Avoid conflict with pipes, ducts, etc. Prepare shop drawings indicating the route of main conduits, ducts and trays for submission to the Construction Manager for approval.

.2 Co-operate with other trades on the site and carry out the work, in such a way, as not to hinder or hold up the work of other trades.

.3 Consult with other trades where their respective installations conflict and re-route conduits, ducts, outlets, equipment, etc, as required, subject to the approval of the Construction Manager.

.4 Obtain from the mechanical and other trades complete detailed wiring diagrams of equipment requiring connections and be responsible for pointing out any discrepancies or the reason why they cannot be adhered to.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Read and conform to:
- .1 Comply with Division 01 – General Requirements and documents referred to herein.

1.2 DEFINITIONS

.1 Validate (for tests and demonstrations): to witness and authenticate successful performance demonstration or record deficiencies; to authenticate, after correction, successful demonstration; these authentications of the tests become references for the Departmental Representative’s certification.

.2 Witness: The Commissioning Authority will observe as required and record summary of test results.

.3 Commissioning Authority: Commissioning Authority in charge of the commissioning process and recommends final acceptance.

1.3 REFERENCES

.1 Latest editions of the following codes and standards:
- .1 CSA C22.1, Canadian Electrical Code, Part 1 - Safety Standard for Electrical Installations.
- .2 CAN/ULC S524, Installation of Fire Alarm Systems.
- .3 CAN/ULC S527, Verification of Fire Alarm Systems.
- .4 NSBC, Nova Scotia Building Code.
- .5 LEED Green Building Rating System Reference Guide.

1.4 DOCUMENTS

.1 In case of discrepancies or conflicts between documents, documents will be governed in the sections of Division 01 - General Requirements.

1.5 COMMISSIONING OBJECTIVES

.1 Objectives of commissioning process are:
- .1 To support quality management through monitoring and checking of installation.
- .2 To verify system performance through testing and commissioning of completed installation.
- .3 To move completed facility from “static completion” state to optimal “dynamic” operating state.
- .4 To transfer facility from Contractor to Owner in such a manner that provision of a quality facility to Owner has been assured.
- .5 To optimize operating and maintenance through delivery of comprehensive quality training and instruction to Owners operating personnel.

.6 To assure provision of accurate and useful historical records, such as, as-built drawings, test certificates, etc. to Owner. Such records provide important data for operating and maintaining systems as well as for future system testing, maintenance or renovations and to trouble shoot and repair the components of systems.

.7 To extend commissioning into operational phase in order to verify performance levels under a range of operating conditions; such as change of seasons. This process will help to avoid unforeseen or hidden operating and maintenance expenses that may develop later on.

.8 Monitor operation, performance and maintenance programs; optimize system's performance under normal operating conditions, partial occupancy, and full occupancy, under the direction and review of Commissioning Authority. This phase lasts throughout warranty period. It may, however, involve activities to ensure completion of:

  .1 System debugging and optimization.

  .2 Completion of training and instruction for operating and maintenance personnel.

  .3 Completion of all commissioning activities on defective, seasonally-sensitive systems, for varying modes and periodic simulated emergency conditions.

.9 Commissioning shall be considered complete when all of the objectives of commissioning, as specified herein, have been achieved.

1.6 COMMISSIONING MEETINGS, SCHEDULING AND REPORTING

.1 The Contractor shall include the commissioning plan in their construction schedule and shall schedule for all tests and equipment start-up in the construction schedule.

.2 Commissioning meetings shall be scheduled as required. The meetings shall address commissioning related responsibilities as well as all specified testing, documentation, O&M manuals, training, and post construction requirements. The testing schedules and results of all tests shall be reviewed at the meetings.

.3 Where construction may be completed in phases, allow for the frequency of meetings to correspond to the varying stages of construction of each phase.

.4 The Contractor shall attend commissioning meetings at regular intervals, as called by the Commissioning Authority.

.5 The Contractor shall schedule work to include specified commissioning related tasks. Cooperate with the Owner's Commissioning Authority, and coordinate sub-trades as required, to successfully demonstrate and verify commissioning related tests.

.6 The Contractor shall schedule work to include specified Commissioning related testing prior to Owner's demonstration and Owner's training.

.7 Testing forms and reports associated with the electrical systems shall be directed to the Departmental Representative and the Commissioning Authority.

.8 The forms and reports to be issued shall include:
  .1 Shop drawings, issued and accepted;
  .2 Equipment verification forms;
  .3 Testing forms;
  .4 Reports resulting from tests;
  .5 Testing schedule;
  .6 Minutes of commissioning meetings.

1.7 WARRANTY

.1 Involvement of Commissioning Authority does not void any guarantees or warranties nor does it relieve Contractor of any contractual responsibilities.

1.8 RESPONSIBILITIES OF COMMISSIONING AUTHORITY

.1 Responsibilities of Commissioning Authority are as follows:
  .1 Design Phase:
    .1 Participate in design team meetings. Obtain Owner's requirements and Departmental Representatives philosophy and intent and expected system performance. This will form the basics of the testing and commissioning documents.
    .2 Provide input and feedback to design team with emphasis on testing, commissioning, operation and maintenance of the proposed system and equipment.
    .3 Provide commissioning document to form part of the Bid documents.
  .2 Construction Phase:
    .1 Review Contractor's approved shop drawing submission for commissioning related issues.
    .2 Prepare commissioning plan based on the contractor's schedule and installation method statement.
    .3 Monitor, check and inspect the installation throughout the construction stages.
    .4 Supervise the commissioning, including scheduling.
    .5 Issue deficiencies reports noting any issues that may have an impact on the commissioning of the equipment or system.
    .6 Attend construction site meetings as required to discuss commissioning related items and any impact on Project schedule.
    .7 Set-up and chair commissioning meetings.
    .8 Witness and validate tests as required; note deficiencies and issue progress reports.
    .9 Work with the project team to expeditiously resolve any problems that may arise due to site conditions.
    .10 Prepare Systems Operating Manual.
    .11 Co-ordinate with Owner, training and instructions provided by Contractors, manufacturers and Suppliers.
  .3 Post-Construction Phase:
    .1 Prepare final report on commissioning, identifying any deficiencies that may be outstanding.

.2 Recommendation of any additional training and/or instruction of operating and maintenance personnel deemed necessary over and above that already provided.

.3 Complete system checks with Contractor:
.1 Once during the first month of building operation.
.2 Once during the third month of building operation.
.3 Once between the fourth and tenth months in a season opposite to the first or third month visit.

1.9 RESPONSIBILITIES OF OWNER

.1 Responsibilities of Owner are as follows:
.1 To provide operating personnel to attend training and instruction regarding specific components, equipment and systems.
.2 To retain the services of independent third parties for system verification and certification as required in the document or by applicable codes.
.3 To observe on-site installation, start-up and testing equipment and systems.

1.10 RESPONSIBILITIES OF DEPARTMENTAL REPRESENTATIVE

.1 Responsibilities of Departmental Representative are as follows:
.1 Review contractor’s shop drawings submission to ensure that the equipment proposed comply with specifications requirements.
.2 Review contractor’s installation program to ensure that the installation sequences have been coordinated with the project schedule.
.3 Monitor, check and inspect the installation throughout the construction stages to ensure the equipment installation is as approved and the installation method, workmanship, procedures will follow the approved submission and method statement.
.4 Inspect the systems installation and issue deficiencies reports. Ensure deficiencies are corrected and certify installation of systems.
.5 Review contractor’s commissioning plan to ensure the proposed tests, the sequences and method of tests conform to the contract requirements; the testing and commissioning sequences coincide with the project schedule.
.6 Review operating and maintenance manuals, balancing and test reports and as-builts for accuracy.
.7 Witness tests; note any deficiencies and provide progress report.

1.11 RESPONSIBILITIES OF CONTRACTOR

.1 Responsibilities of Contractor are as follows:
.1 Construction Phase:
.1 To manage and ensure entire installation comply with requirements of the Contract Documents.
.2 Submit shop drawings complete with Contractor’s Stamp of Review.
.3 Submit working detail (interference or installation) drawings, as required.
.4 The Contractor shall coordinate with the Commissioning Authority to prepare the Construction Commissioning Plan.

.5 Complete commissioning data test forms.

.6 Submit installation method statement. This generally includes:
  .1 Method of equipment delivery to the installation location on site.
  .2 Prerequisite preparation for delivery, such as completion of the factory testing and the completion of site work to accept this equipment.
  .3 Installation method and sequences of installing the equipment and the associated connections to the equipment.

.7 Submit an installation schedule. This schedule shall include:
  .1 Time schedule of each activity, with lead and lag time allowed and indicated.
  .2 Shop drawings and working detail drawings submission.
  .3 Major equipment delivery and factory testing date.
  .4 Coordinated installation activities and sequences in compliance with the Construction Manager's project schedule and other trade's installation schedule.
  .5 Schedule of testing and commissioning of the systems and major equipment.

.8 Submit a commissioning schedule. This schedule shall include:
  .1 Time schedule for system and equipment commissioning which are in compliance with the timing and sequences of installation schedule stated above. In this schedule allow for additional time for testing and commissioning, such that re-test of the equipment can be performed in a timely manner if required without impacting the overall project schedule or cause delay to Project completion.
  .2 Dates for completion of required factory tests prior to equipment delivery to the site shall be indicated in the schedule.
  .3 Prepare and submit testing and commissioning method statements for review and approval.
  .4 Prepare and submit testing and commissioning record or report forms for review and approval.

.9 Attend progress and commissioning meetings.

.10 Promptly rectify or replace reported deficiencies and defects.

.11 Where required by codes and/or specification, retain manufacturers and/or independent third parties to provide service for testing and certification of the systems and training of Owner's personnel.

.12 Provide training and instruction to the Owner's operating personnel.

.13 Perform testing and commissioning of equipment and systems to the satisfaction of the Departmental Representative and Commissioning Authority as stated in approved schedule and method described above. Testing and commissioning will be witnessed by the Commissioning Authority as required. Contractor or his retained agents shall also record procedure and findings in approved test and record forms. Submit test and record forms with the signature of the tester for review and approval to the Departmental Representative and Commissioning Authority.

.14 Pay for and be responsible for all inspections required by codes, specification and Authorities having Jurisdiction. Obtain and submit all Certificate of Approval for such inspections and verifications.

.15 Submit for review as-builts drawings including those for location of control devices and wiring and operating and maintenance manuals for each piece of equipment as per the specification requirements.
.16 Provide Operating and Maintenance Manuals for review by the Departmental Representative and Commissioning Authority with all the testing and commissioning results and reports incorporated.
.17 Obtain, issue and assign warranties for equipment and systems to the Owner.
.18 Provision of all necessary test equipment shall be the responsibility of the contractor. Provide recently validated calibration certificates for all equipment to be used for verification prior to testing and commissioning commencement.

.2 Post-Construction Phase:
.1 Optimize operation according to occupant’s needs, using the System Operation Manual prepared by the Commissioning Authority as reference points.
.2 Complete all commissioning procedures and activities and performance verification procedures which were delayed or not concluded during the commissioning phase.
.3 Complete system checks:
.1 Once during the first month of building operation.
.2 Once during the third month of building operation.
.3 Once between the fourth and tenth months in a season opposite to the first or third month visit.
.4 Complete rectification of all deficiencies revealed by these checks. Equipment manufacturers involved in commissioning shall participate in systems checks.
.5 Revise all “as-built” and operating and maintenance documents to reflect all changes, modifications, revisions and adjustment upon completion of commissioning.
.6 Schedule a question and answer session for the operating and maintenance personnel 3 months after handover of the facility to the Owner’s. The duration of this session or sessions will be dictated by the number of questions or concerns that shall be addressed.

1.12 COMMISSIONING INVOLVEMENT

.1 Commissioning Authority shall direct, witness and validate as required; and Contractor and/or his Suppliers or retained Independent Third Party Agents shall perform the following:
.1 Check and ensure installation of systems and equipment to ensure installations are completed and in a proper and safe state ready for testing and commissioning.
.2 Run and test the systems and equipment through their design parameters to verify their capabilities in performance, sequencing, safety protection and alarms annunciation.
.3 Ensure deficiencies and defects found are rectified and replaced and the systems and equipment re-tested as required.
.4 Arrange and provide demonstration and training of Owner’s personnel.
.5 Issue Operating and Maintenance Manuals for systems and equipment.

1.13 SYSTEMS TO BE COMMISSIONED

.1 Electrical systems shall include but not limited to following:
.1 Main Switchboard
.2 Grounding System
.3 Distribution Panelboards
.4 Branch Panelboards
.5 Transformers
.6 Distribution System
.7 Coordination Study and On-Site Testing
.8 Fire Alarm System
.9 Security System
.10 Door Access System
.11 Telecommunications System.

1.14 TESTING EQUIPMENT

.1 The Contractor and manufacturer shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Authority and Departmental Representative for approval.

1.15 DOCUMENTATION

.1 The Contractor shall record test results and procedures on approved record forms and submit the forms together with copies of test certificates to Departmental Representative and Commissioning Authority for review and approval.

.2 When results are validated, Commissioning Authority shall incorporate those records in his System Operating Manual. He shall also make entry of those test results into appropriate sections of the System Operating and Maintenance Manual as reference for future system/equipment performance tests.

1.16 COMMISSIONING PROCESS

.1 Commissioning Authority: to perform and complete all work as specified in the “GENERAL” Section of this specification “Responsibilities of Commissioning Authority”.

.2 Contractors: To perform and complete all works as specified in the “GENERAL” Section of this specification “Responsibilities of Contractor”. In general, it shall include complete activation of all systems; calibration, test, and verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequence of operation; rectification of deficiencies; recording of test results for submission; demonstration, instruction and training of Owner’s operating and maintenance personnel; follow-up during first year of operation for fine tuning and building service monitoring.

.3 Equipment verification: Contractor shall test and verify proper operation of all equipment and systems prior to start of commissioning and record all results from the test for each piece of equipment. Forms shall be included in the Operating and Maintenance Manual. Equipment data shall include, but is not limited to:
- .1 Manufacturer’s name, address and telephone number.
- .2 Distributors’ name, address and telephone number.
- .3 Make, model number and serial number.
- .4 Elecitrcal: voltage, ampere rating, fault rating, frequency, breaker size, fuse size, overload size.
- .5 Equipment enclosure type.
- .6 Any other special characteristics.

1.17 TESTING FOR ELECTRICAL SYSTEMS

.1 All systems as specified in Division 26 of the specification.

.2 Test and commission equipment and systems as per Electrical Specification, and the following requirements.

.3 Contractor to submit test reports including the test procedures, results of all items inspected, checked, measured and tested. Comments and deficiencies should also be noted in the reports.

.4 Low voltage switchboard:
- .1 Manufacturer shall carry out the following pre-service tests and measurements after the board is energized.
- .2 All pre-service checks, inspections and testing as recommended by the manufacturer.
- .3 Check and record nameplate data.
- .4 Check and inspect the switchboard to ensure it is installed in accordance with the manufacturer’s recommendations and to the Code requirements.
- .5 Check that the installation is complete and ready and safe to carry out the testing.
- .6 Check and report the switchboard enclosure is suitable for the environment in which it is installed.
- .7 Check and test grounding is completed and satisfactory prior to carrying out any test.
- .8 Check and record the entire switchboard is clean and free of debris before the testing.
- .9 Check the mechanical and electrical operation of the switches, breakers
- .10 Check all connecting bolts are tightened to the correct torque values.
- .11 Megger test.
- .12 Set all protective devices to the settings as per the approved Coordination Study.
- .13 Test and calibrate the protective devices by secondary current injection. Record the magnitude of the test current, the actual tripping time, and the tripping time from curve.
- .14 Check all the indication lights and control switches for correct functions.
- .15 Set up, check and test the proper operations of the TVSS, measuring, indicating and recording meters.

.16 After the board is energized, check and test phase sequence, voltages and load on the system and on each feeder.

.5 Distribution cables:
.1 Check cables are properly installed, terminated and tightened to the correct torque values.
.2 Check and record cable sizes, types and method of installation.
.3 Check and confirm the installed cable sizes are of adequate rating, taking into consideration the type of cable, the method of installation, the correction factors and any other requirements.
.4 Grounding test to ensure the equipment, the conduit and the cable armour/sheath, if applicable, are properly grounded.
.5 Megger test.
.6 Check and measure voltage and current. For cables in parallel, measure load current on each cable.

.6 Transformers:
.1 Check and record nameplate data.
.2 Check and report the transformer enclosure is suitable for the environment in which it is installed.
.3 Check and record sizes and types of primary and secondary protection devices, conductor sizes and types.
.4 Check cables are properly installed, terminated and tightened to the correct torque values.
.5 Megger the primary and secondary windings.
.6 Measure the primary and secondary winding resistances.
.7 Measure turns ratio, capacitance and dissipation factor.
.8 Grounding test to ensure transformer is properly grounded.
.9 Polarity and phase sequence tests.
.10 Sound level test for different points at 1 m away from transformers.
.11 Check and record transformer primary and secondary voltages and load current. Check and record transformer on-load temperatures.

.7 Distribution and branch panelboards:
.1 Check and record nameplate data.
.2 Check and report the panel enclosure is suitable for the environment in which it is installed.
.3 Check cables are properly installed, terminated and tightened to the correct torque values.
.4 Check and test to verify the panelboard directory is correct.
.5 Include the directory in the test records. The directory shall contain the size of each breaker, equipment served, cable type and size.
.6 Check and test the voltage drop is within the specified limit from the service entrance switchboard to the distribution panels and branch panelboards.
.7 Test branch circuits voltage drop is within the requirements.
.8 Grounding test to ensure panelboards are properly grounded.
.9 Megger test.
.10 Set all protective devices to the settings as per the approved Coordination Study.

.11 Test and calibrate the protective devices by secondary current injection. Record the magnitude of the test current, the actual tripping time, and the tripping time from curve.
.12 Measure voltage and load current on each phase. Submit test reports to Departmental Representative. When required, re-arrange branch circuits as directed by the Departmental Representative for proper load balancing.

.8 Coordination study and on-site testing:
.1 Set up all the protective devices, check and verify the frame size, rating of the breakers, relays, switches and types of fuses and record all such ratings and settings in his reports.
.2 Test and calibrate, by secondary injection, all protective devices as per the settings recommended in the study.

.9 Fire alarm system:
.1 Prior to carrying out site test, submit a fire alarm system operation matrix to the Departmental Representative and Commissioning Authority. This matrix shall include of operation of the fire alarm system and the operations of all systems interfaced with the fire alarm system.
.2 Check and record nameplate data.
.3 Check and report the panel enclosure is suitable for the environment in which it is installed.
.4 Check and verify system is installed to specification, NSBC, and CAN/ULC-S524 requirements.
.5 Perform system verifications and tests according to CAN/ULC-S537.
.6 Check and verify all system operations shown in the matrix.
.7 Perform system integration test to verify proper fire alarm system operation, and the proper operations of all systems interfaced with the fire alarm system.
.8 Submit verification reports and system operation verification reports.

.10 Other systems as per specification requirements.

1.18 OPERATION AND MAINTENANCE MANUAL

.1 Contractor shall prepare and submit the Operating Manual as detailed in the specification to Departmental Representative six (6) weeks prior to beginning of training.

.2 Contractor shall re-submit the manual should the Departmental Representative find deficiencies. Training shall not begin until the manual has been accepted by the Departmental Representative. One copy of the manual shall be forwarded to Commissioning Authority in good quality, vinyl covered binders.

.3 Project directory shall contain the names, addresses, fax numbers and telephone numbers of Contractors, Subcontractors, manufacturers and manufacturer’s representatives.

.4 The Electrical manual shall be contain, but not limited to the following:
.1 Shop drawings.
.2 As-built drawings
.3 As-built riser diagrams.

.4 Equipment list.
.5 Testing and verification forms.
.6 Certification forms.
.7 Panel directory as applicable.
.8 Manufacturer’s literature on installation, operation and maintenance of the equipment, including trouble shooting procedures.
.9 Recommended special tools and equipment for the operation and maintenance of the equipment.
.10 Spare parts list.
.11 The operating procedures shall be the recommended manufacturer’s operating procedures for the equipment.
.12 The maintenance procedures shall include Scope of Work, frequency of activity, parts required and necessary documentation.
.13 Spare parts list shall be manufacturers’ recommended list for maintenance purposes.
.14 Trouble shooting guide shall be manufacturer’s recommendations for the equipment.
.15 Equipment list shall include make, model, serial number, voltage, rated current, number of phase and wire and fault rating.

.5 A copy of the Operating and Maintenance Manual shall be submitted to the Owner.

1.19 SYSTEMS OPERATING AND MAINTENANCE MANUAL

.1 The Systems Operating Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.

.2 Systems Operating Manual shall be prepared by Commissioning Authority using data collected by Contractor and test results.

1.20 OPERATING TRAINING AND INSTRUCTIONS

.1 Contractor and equipment manufacturers shall provide operator training for each electrical system and equipment.

.2 The training and instruction shall be provided by qualified technicians and shall be conducted in a classroom setting at the equipment or system.

.3 Training and instruction will begin when the Operating and Maintenance Manual has been approved and delivered to Owner.

.4 Each session shall be structured to cover:
.1 The Operating and Maintenance Manual;
.2 Operating procedures;
.3 Maintenance procedures;
.4 Trouble-shooting procedures;
.5 Manufacturer’s or service representative’s name, address and phone number.

.5 Contractor shall prepare a detailed training and instruction plan. This plan shall include the outline of all sessions and identification of the training presenters.

.6 Submit the plan including a copy of training manual for Commissioning Authority's review and approval.

.7 Provide course documentation for up to six (6) people.

.8 The sessions shall be coordinated and videotaped by the Commissioning Authority.

.9 Training and instruction shall be provided for the electrical systems wherever applicable.

.10 Training and instruction requirement for the electrical system shall include a walk-through of building by Contractor. During the walk-through the Contractor shall:
- .1 Identify, describe and explain the function of equipment.
- .2 Detailed explanation of the operation, including mechanical and electrical operation of the equipment; procedures and sequence of operation; procedures of switching.
- .3 Detailed explanation of the maintenance of the equipment including procedures and items to check for.
- .4 Safety procedures to be implemented before the maintenance.
- .5 Interface and control with other equipment.
- .6 Fault finding procedures.

.11 When each session has been completed, the Commissioning Authority shall sign to certify completion.

1.21 SYSTEM DEMONSTRATION AND TURNOVER

.1 System demonstration and turnover to the Owner shall occur when:
- .1 The installation is complete.
- .2 Acceptance test conducted by the Departmental Representative has been successfully completed.
- .3 Commissioning Authority system testing has been successfully complete.
- .4 Training and instruction has been completed.
- .5 Operating and Maintenance Manual has been accepted.
- .6 Shop drawings have been updated.
- .7 As-built drawings have been completed.

.2 Systems demonstration shall be conducted by Contractor and manufacturers. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.

1.22 TESTING FORMS

.1 Contractor and manufacturers shall provide information required to complete forms listed in this Section and any other additional data sheets not included in this specification, but required for the electrical systems of this Project. All forms to be provided by the Contractor and shall be approved by the Departmental Representative and the Commissioning Authority.

.2 Commissioning index form shall be maintained by Commissioning Authority to track progress of the commissioning requirements.

.3 Electrical testing and verification forms to be completed are as follows wherever applicable, but not limited to:
  .1 Equipment test form.
  .2 System and equipment warranty dates form.
  .3 System verification form.
  .4 Test identification form.
  .5 Testing and start-up schedule form.
  .6 Switchboard testing and commissioning form.
  .7 Transformer testing and commissioning form.
  .8 Distribution cable testing and commissioning form.
  .9 Panelboard testing and commissioning form.
  .10 Lighting and Lighting Control testing and commissioning form.
  .11 Fire alarm testing and verification form
  .12 Security/CCTV/access testing and commissioning form.

1.23 EQUIPMENT AND SYSTEM WARRANTIES

.1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.

.2 Contractor shall fill-out the warranty form listing the equipment and systems and the start and finishing dates for warranty.

.3 Refer to Division 01 and Division 26 of the specification for the requirements during the warranty period.

.4 Contractor shall re-visit the building during the warranty period with Departmental Representative, Commissioning Authority and Owner. During this visits the performance of the system shall be reviewed. The Owner shall organize this visit.

.5 At this meeting, the Owner, Departmental Representative and Commissioning Authority shall review the performance of the systems. If the performance is satisfactory then no further action need to be taken. If unsatisfactory then Contractor will be instructed to correct deficiencies, at his cost, to the satisfaction of Departmental Representative.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Removals and alterations of electrical equipment and systems.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following :
   .1 CSA C22.1, Canadian Electrical Code, Part 1 Safety Standard for Electrical Installations.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 26 05 00 – Common Work Results - Electrical.

Part 2 Products

2.1 NOT APPLICABLE

Part 3 Execution

3.1 GENERAL REMOVALS AND ALTERATIONS

.1 In general, work of this section consists of removal of existing Motors, Disconnect Switches, Starters, Transformers, Circuit Breakers etc. in area of renovation, and any associated materials (redundant wiring, cabling, conduits, etc.). except those designated to stay or for reuse.

.2 All removal or modification work of electrical construction shall be performed in accordance with the safety standards outlines in CSA C22.1.

.3 Carefully coordinate with the required remodeling work, cutting and patching, etc. performed by other trades. Remove or relocate existing electrical conduits, wires, devices, fixtures, and other equipment as necessary.

.4 In areas where existing ceilings are required to be removed for above ceiling work by this trade or other trade Contractors, fixtures and devices shall be retained for installation in new ceiling.

3.2 REMOVAL AND EXTENSION OF EXISTING ELECTRICAL WORK

.1 Remove and extend existing electrical work under provisions of this Section.

.2 Remove, relocate, and extend existing installations to accommodate new construction.

.3 Remove abandoned wiring to source of supply.

.4 Maintain electrical continuity to equipment which is to remain.

.5 Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

.6 Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

.7 Disconnect and remove abandoned panelboards and distribution equipment.

.8 Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

.9 Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

.10 Repair adjacent construction and finishes damaged during demolition and extension work. Provide modifications to assure that circuits or systems wiring shall not pass through outlet or junction boxes which may be rendered inaccessible by changes made to the building.

.11 Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

.12 Extend existing installations using materials and methods as specified in other Sections.

.13 Fire protection services, e.g. fire alarm, emergency lighting, exit lighting, etc. are considered essentials services and must be maintained in operation at all times.

.14 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

.15 Maintain existing systems in service until new systems are accepted or as otherwise indicated. Disable systems only to make switchovers and connections. Notify the Project Manager at least 36 hours before partially or completely disabling systems. Make temporary connections to maintain services as required.

3.3 SALVAGE MATERIAL

.1 Materials and equipment identified on the drawings or herein as being reused are to be taken down, stored, reinstalled, etc., as required to allow for new construction.

.2 Contractor must identify any damaged equipment or materials intended for reuse prior to demolition and point out deficiencies to the Departmental Representative at the time.

.3 All materials and equipment removed under the work of this Section becomes the property of the Contractor unless indicated otherwise.

3.4 CLEANING

.1 In accordance with Section 01 74 11 – Cleaning.

.2 Existing equipment to be reused shall be cleaned in accordance with Section 26 05 00 – Common Work Results - Electrical.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for wire and box connectors (0-1000 V).

1.2 RELATED SECTIONS

.1 None.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
- .1 CSA C22.2 No. 18.1, Metallic Outlet Boxes.
- .2 CSA C22.2 No. 18.2, Non-Metallic Outlet Boxes.
- .3 CSA C22.2 No. 65, Wire Connectors.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC) latest edition of the following:
- .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA):

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors to: CSA C22.2 No. 65, with current carrying parts of copper, copper alloy, and insulating cap, sized to fit copper conductors.

.2 Fixture type connectors to: CSA C22.2 No. 65, with current carrying parts of copper, copper alloy, and insulating cap, sized to fit copper conductors.

.3 Bushing stud connectors to: EEMAC 1Y-2 and NEMA shall consist of connector body and stud clamp bolt, clamps and bolts sized to fit stranded copper or aluminum conductors.

.4 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to: CSA C22.2 No. 18.1 and CSA C22.2 No. 18.2.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

.1 Install pressure type connectors for conductors larger than #10 AWG, and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65.
.2 Install fixture type connectors for conductors and control wiring #10 AWG and smaller. Plier tighten all wire nut joints and connections.
.3 Install bushing stud connectors in accordance with EEMAC 1Y-2 and NEMA.
.4 For aluminum conductors: apply coat of zinc joint compound on conductors prior to installation of connectors.

.2 All connections shall be made mechanically secure. The size of connectors shall be according to manufacturer’s recommendation for each wire size and combination of wires.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for wire and cables (0-1000 V).

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

.2 Section 26 05 20 – Wire and Box Connectors (0-1000 V).

.3 Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
  - .3 CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittals Procedures.

Part 2 Products

2.1 BUILDING WIRES

.1 Conductors: stranded for #10 AWG and larger. Minimum size: #12 AWG for circuits exceeding 50 volts to ground.

.2 Copper conductors: size as indicated, with 600V insulation of chemically cross-linked thermosetting polyethylene material rated RW90 XLPE.

.3 Wiring for specialized systems such as fire alarm, public address, structured cabling, multi-media, etc. as indicated in other sections or on drawings.

2.2 TECK CABLE

.1 Cable: to CAN/CSA-C22.2 No. 131.

.2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper and aluminum, size as indicated.

.3 Insulation:
  - .1 Type: Chemically cross-linked thermosetting polyethylene rated type RW90, 600V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: thermoplastic polyvinyl chloride material.

.7 Fastenings:
 .1 One hole steel straps to secure surface cables 50mm and smaller. Two hole steel straps for cables larger than 50mm
 .2 Channel type supports for two or more cables at 1524mm centers.
 .3 Threaded rods: 9.5mm dia. to support suspended channels.

.8 Connectors:
 .1 Watertight, approved for TECK cable.

2.3 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from aluminum strip.

.4 Connectors:
 .1 Steel set screw.
 .2 Anti-short.

2.4 VARIBALE FREQUENCY/SPEED DRIVE (VFD/VSD) CABLE

.1 Cable: to CSA C22.2 No. 123.

.2 Conductors:
 .1 Grounding conductor: three (3) sectored copper grounds.
 .2 Circuit conductors; stranded copper, size as indicated. Minimum size: 12 AWG.

.3 Insulation:
 .1 Chemically cross-linked thermosetting polyethylene, type RW90, rated 1000V.

.4 Inner Jacket: polyvinyl chloride material.

.5 Armour: continuous corrugated aluminum.

.6 Overall covering: thermoplastic polyvinyl chloride material

.7 Connectors: approved for VFD/VSD cable.

2.5 CONTROL CABLES

.1 Type LVT: Soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket, CSA C22.2 No .0.3, FT6.

.1 Cable may be FT4 rated where installed in conduit.

Part 3 Execution

3.1 GENERAL CABLE INSTALLATION

.1 Terminate cables in accordance with Section 26 05 20 – Wire and Box Connectors (0-1000 V).

.2 Cable colour coding: to Section 26 05 00 – Common Works Results - Electrical.

.3 Conductor length for parallel feeders to be identical.

.4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.5 Neutral conductor: continuous with no fuses, switches, or breaks of any kind.

.6 The Contractor shall run all circuits so that the voltage drop, in no case, shall exceed 3% of the line volts. Voltage drop calculation: distance is measured to the last device along the conductor run. The neutral wire, wherever it is run shall be continuous with no fuses, switches, or breakers of any kind.

.7 The minimum conductor size for all branch circuits is to be #12 AWG.

.8 For 15 A, 120 V branch circuits, the following table shall be followed:

Branch Circuit One-Way Length from Panel to Load (Incl. Vertical Drops)	Phase Wire Size	Dedicated Neutral	Common Neutral	Bond Wire Size
Up to 24m	#12 AWG	#12 AWG	#10 AWG	#12 AWG
24m to 38m	#10 AWG	#10 AWG	#8 AWG	#12 AWG
38m to 56m	#8 AWG	#8 AWG	#6 AWG	#10 AWG

.9 For 20 A, 120 V branch circuits, the following table shall be followed:

Branch Circuit One-Way Length from Panel to Load (Incl. Vertical Drops)	Phase Wire Size	Dedicated Neutral	Common Neutral	Bond Wire Size
Up to 18m	#12 AWG	#12 AWG	#10 AWG	#12 AWG
18m to 29m	#10 AWG	#10 AWG	#8 AWG	#12 AWG
29m to 43m	#8 AWG	#8 AWG	#6 AWG	#10 AWG

.10 The requirements for accommodating larger common or “shared” branch circuit neutral conductors where the application might warrant such, could restrict the use of some types of AC90 cables. In certain instances however, the installation of AC90 cable (where permissible), and the use of “oversized” neutral conductors where required, is more than acceptable.

.11 Oversized #10 AWG branch circuit wiring conductors to be extended to outlet box of device they feed. Oversized #8 or #6 AWG branch circuit wiring conductors to be extended from panelboard to junction box located on wall or ceiling directly above outlet or device they feed. A #8 or #6 AWG wire can be reduced to #10 AWG for vertical portion of drop only.

.12 All stranded conductors are to be twisted together prior to any types of terminations taking place, but not necessarily limited to, some of the following areas:
- .1 Receptacles.
- .2 Lighting switches.
- .3 Neutral terminal strips.
- .4 Bonding terminal strips.
- .5 Circuit breakers.
- .6 Disconnected switches.
- .7 Magnetic and manual starters.
- .8 Magnetic contactors.
- .9 Relays.
- .10 Terminating lugs, etc.

3.2 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:
- .1 In conduit systems in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Use vibration proof expanding spring wire connectors for #10 AWG and smaller.

.2 All various types of cables are to be installed parallel or perpendicular to building lines and shall be adequately secured to the building structure at not more than 1.5m intervals or as otherwise indicated, in such a manner as to ensure they are protected from potential types of mechanical damage occurring. Install independent supports for cabling in ceiling spaces, and do not use those of other trades. Do not secure cables to mechanical systems piping or ducts, suspended ceiling support wires, etc.. The laying of unsupported cables of any types whatsoever directly atop ceiling grid system is strictly prohibited

.3 The installation of surface wiring on walls or in open type ceilings shall always be in EMT type conduit complete with associated steel type connectors and couplings.

.4 Install and secure surface cables directly to underside of metal decking and/or ceiling slab where installed in any concealed ceiling spaces.

.5 All cables are to be secured to concrete, concrete block, brick, metal docking/siding, with nylon type inserts complete with self-tapping metal screws.

.6 Cables are always to be installed as high as possible to underside of structure.
  .1 Where cables are installed in same direction as steel joists, they are also to be secured as high as possible to underside of metal decking and/or structure. Do not install cables in the upper portions of any Q-decking.

.7 The grouping together of cables to form a bundle for securing purposes, is acceptable provided that the following procedures are adhered to.
  .1 In addition to securing cables at 1.5m intervals to structure, multiple or bundled groups of cables (including low voltage types), shall be tie-wrapped together at mid-point between each structure support, or every 762mm. Secure to structure at 1.5m intervals, and secure together (between structure supports) at 1.5m intervals.

.8 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

3.3 INSTALLATION OF TECK90 CABLE

.1 Group cables wherever possible on channels.

3.4 INSTALLATION OF VFD/VSD CABLE

.1 Install drive cable between VFD/VSD output and motor load.

.2 Install cables:
  .1 Group cables wherever possible on channels

3.5 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible.

.2 Support and securing of cables shall not be derived from suspended ceiling support wires or by laying on top of the ceiling.

.3 Pliable type cables are to be secured to building structure at 1m intervals and tye-wrapped together at mid-point between each structure support.

.4 Cables are not to be installed on exposed walls and/or ceilings.

3.6 INSTALLATION OF CONTROL CABLES

.1 All control cables shall be secured directly to the structure utilizing adjustable type cable supports.

.2 Cables shall be tie-wrapped neatly.

.3 Ground control cable shield.

3.7 IDENTIFICATION

.1 Provide identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

3.8 TESTING

.1 After all wiring devices have been installed, the Contractor shall test all systems to make sure there are no grounds, leaks, or shorts. Such tests shall be performed to the satisfaction of both the inspection authority having jurisdiction and the Departmental Representative.

.2 Perform megger tests in accordance Section 26 05 00 – Common Work Results - Electrical

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures for secondary grounding system.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE) latest edition of the following:
   .1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

.2 Canadian Standards Association, (CSA International) latest edition of the following:
   .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
   .2 CSA C22.2 No. 0.4, Bonding of Electrical Equipment.
   .3 CSA T527, Grounding and Bonding for Telecommunications in Commercial Buildings.

.3 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA) latest edition of the following:
   .1 TIA/EIA-607, Commercial Building Bonding and Grounding Requirements for Customer Premises.

Part 2 Products

2.1 EQUIPMENT

.1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.

.2 Insulated bonding conductors: green, type RW90.

.3 Wire connectors: compression, sized to fit copper conductors.

.4 Non-corroding accessories necessary for grounding system, type, size, material as required, including but not necessarily limited to:
   .1 Grounding and bonding bushings.
   .2 Protective type clamps.
   .3 Bolted type conductor connectors.
   .4 Thermit welded type conductor connectors.
   .5 Bonding jumpers, straps.
   .6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION – GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, and accessories in accordance with CSA C22.1, CSA C22.2 No. 0.4 and requirements of local authority having jurisdiction.

.2 All equipment and exposed non-current carrying metal, conduits and parts shall be permanently and effectually grounded to meet the requirements of CSA C22.1, and as indicated on the drawings and further specified. Standard set either by drawings or specifications which are above those covered by CSA C22.1, shall not be reduced under any circumstances.

.3 Install connectors in accordance with manufacturer's instructions.

.4 Protect exposed bonding conductors from mechanical injury.

.5 Use mechanical connectors for grounding connections to equipment provided with lugs.

.6 Soldered joints not permitted.

.7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.8 Where EMT conduit is used, run ground wire in conduit.

.9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.10 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.11 Ground secondary service pedestals.

.12 All bond wires are to be twisted together with a screw on type wire connector and then placed in the rear of the outlet box in such a manner as to minimize obstructions.

.13 The incoming (panel side) bonding conductor shall be secured to the bonding screw of each outlet box, before connecting conductors to the back of the outlet box.

.14 Generally, minimum grounding shall be provided by the metallic conduit/outlet box system and by the bond wire in cables. Additional insulated ground wires shall be provided as follows.

- .1 In all EMT conduit feeders that supply panelboards, distribution boards, motor control centres, and transformers. All sized as per Table 16A, or Table 16B (as applicable) CSA C22.1.
- .2 All non-metallic conduit systems (e.g. PVC conduit).

.3 A separate green bond conductor, sized as per Table 16A, or Table 16B (as applicable) of the CSA C22.1, shall be installed in each EMT conduit run for branch circuit wiring.

.4 Where ground conductors terminate at ground buses in switchboards or panelboards, the connection shall be made with a compression lug, which shall be secured to the bus with nut, bolt and two Bellevelle washers. Size of bolts shall be to suit lug and shall be properly torqued and marked.

.5 A ground bus shall be supplied and installed in the main electrical room and the main communications room. Connections to these busses shall be via:

.1 Copper one hole, short barrel type lugs for all sizes up to #6 AWG.

.2 Copper two hole, long barrel type lugs for all sizes #4 AWG and larger.

.3 To be bolted to bus bar via tapped threaded hole complete with accompanying flat and lock washers.

.4 Use "Burndy" type "ground to bus" connectors series "GB" or "GC" or approved equals, where "fed through" type terminations to bus bars are required for either single or parallel connections.

3.2 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of primary 600V system, and secondary 208V system.

.2 Transformer grounds shall be drawn in with the primary conductors.

3.3 EQUIPMENT BONDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list: Transformers, distribution panels, frames of motors, starters, control panels etc.

3.4 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures of hangers and supports for electrical equipment and systems.

1.2 RELATED SECTIONS

.1 None.

Part 2 Products

2.1 SUPPORT CHANNELS

.1 U shape, size 25mm square, 2.5mm thick, surface mounted or suspended.

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to hollow or solid masonry, tile and plaster surfaces with lead anchors or nylon shields.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Toggle bolts shall not be used to support any equipment, including light fixtures from any plasterboard or drywall type construction.

.4 Secure surface mounted equipment with twist clip fasteners to inverted T-bar ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Fasten exposed conduit or cables to building construction or support system using straps:
- .1 One hole steel straps to secure surface conduits and cables 50mm and smaller.
- .2 Two hole steel straps for conduits and cables larger than 50mm.
- .3 Beam clamps to secure conduit to exposed steel work.

.7 Suspended support systems:
- .1 Support individual cable or conduit runs with 4.5mm dia. threaded rods and spring clips.
- .2 Support 2 or more cables or conduits on channels supported by 4.5mm dia. threaded rod hangers where direct fastening to building construction is impractical.

.8 For surface mounting of two or more conduits use channels at 1524mm on centre spacing.

.9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.11 Do not use ty-wraps for supporting purpose. They may only be utilized to secure various systems wiring in place but in no instance are they to be used as a substitute for approved type metal straps, clamps, etc…

.12 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.

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

.15 Use channels where required to support electrical equipment where there is no wall support.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials, components and installation procedures for splitters, junction, pull boxes, and cabinets.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
   .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:
   .1 Provide manufacturer’s printed product literature, specifications and datasheets and include product characteristics, performance criteria, physical size, finish and limitations

Part 2 Products

2.1 SPLITTERS

.1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 Spare terminals: minimum three spare terminals on each lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

.1 Construction: sheet metal with all welded steel corners and screw-on flat covers for surface mounting.

.2 All flush boxes shall be Type D. Covers for flush mounted boxes shall extended a minimum of 25mm all around.

.3 Concealed junction boxes (within ceiling space) shall not be smaller than 102mm square.

2.3 CABINETS

.1 Construction: sheet steel with all welded steel corners, hinged door, handle, latch, lock, two (2) keys and catch.

.2 Type E - Empty: surface return flange, flush overlapping sides, for surface mounting.

.3 Type T - Terminal: surface return flange, flush overlapping sides, for surface mounting, containing 19mm G1S plywood backboard.

Part 3 Execution

3.1 SPLITTER INSTALLATION

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations and secure them adequately to the building structure. Pull boxes installed in the middle of conduit runs without backing are not acceptable.

.2 All suspended junction, pull and outlet boxes shall be supported with minimum size 9.5mm threaded rods, nuts and flat washers. Threaded rods shall be secured to boxes with one flat washer and nut installed on both sides of box. One rod required for all boxes sized up to and including 102mm square. Two rods required for boxes larger than 102mm square, up to and including 203mm square. A minimum of four rods required for all boxes larger than 203mm square.

.3 Mount cabinets with top not higher than 2m above finished floor.

.4 Install terminal block as indicated in Type T cabinets.

.5 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run or two 90 degree bends between pull boxes.

3.3 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name, voltage and phase.

.3 All junction and pull boxes coverplates are to be colour coded.

.4 Concealed junction and pull boxes installed above ceilings or behind walls, are to have their locations identified on room sides of access opening frames with properly coloured coded identification discs.

.5 Coverplates for junction and pull boxes located above finished ceilings housing branch circuits shall have each branch circuit number neatly identified on plate. Felt marker may be used for this purpose.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures of outlet boxes, floor boxes, conduit boxes and fittings for electrical equipment and systems.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA) latest edition of the following:
  .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 Underwriters Laboratories (UL).

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102mm square or larger outlet boxes as required.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347V outlet boxes for 347V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

.1 One-piece electro-galvanized steel construction.

.2 Single and multi-gang flush device boxes for flush installation, minimum size 76mm x 50mm x 25mm or as indicated. 102mm square outlet boxes when more than one conduit enters one side with extension and tile rings as required.

.3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102mm x 50mm x 50mm.

.4 102mm square or octagonal outlet boxes for lighting fixture outlets.

.5 Extension and tile rings for flush mounting devices in finished tile walls.

2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

.1 Electro-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and tile rings as required.

2.5 CONDUIT BOXES

.1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

2.6 FITTINGS – GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent any debris.

.3 Conduit outlet bodies for conduit up to 25mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

2.7 FITTINGS FOR EMT CONDUIT

.1 Steel set screw type connectors and couplings.

2.8 FITTINGS FOR FLEXIBLE CONDUIT

.1 Threaded type steel couplings and fittings.

.2 Compression nut, grounding ferrule, sealing ring and body shop.

2.9 FITTINGS IN WET OR DAMP LOCATIONS

.1 Watertight fittings on conduit in wet or damp locations

Part 3 Execution

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work

.3 For flush installations mount outlets flush with finished wall using tile rings to permit wall finish to come within 6mm of opening.

.4 Provide correct size of openings in boxes for conduit and armoured cable connections. Do not install reducing washers.

.5 Vacuum clean interior of outlet boxes before installation of wiring devices.

.6 Identify systems for outlet boxes as required.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures of conduits, conduit fastenings and conduit fittings for electrical equipment and systems.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA) latest edition of the following:
  - .1 CSA C22.2 No. 18.3, Conduit Tubing and Cable Fittings.
  - .2 CSA C22.2 No. 45.1, Electrical Rigid Metal Conduit - Steel.
  - .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .5 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

Part 2 Products

2.1 CONDUITS

.1 Rigid Metal Conduit: to CSA C22.2 No. 45.1, galvanized steel threaded.

.2 Electrical Metallic Tubing (EMT): to CSA C22.2 No. 83, with couplings.

.3 Rigid PVC Conduit: to CSA C22.2 No. 211.2.

.4 Flexible Metal Conduit: to CSA C22.2 No. 56, aluminum and liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50mm and smaller. Two hole steel straps for conduits larger than 50mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1.5m on-center.

.4 Threaded rods, 9.5mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

.1 Fittings: to CSA C22.2 No. 18.3, manufactured for use with conduit specified. Coating: same as conduit.

.2 Ensure factory "ells" where 90 degree bends are required for 25mm and larger conduits.

.3 Couplings and connectors for EMT shall be set-screws steel or water-tight. Threaded plastic or metal bushings shall be installed on all EMT connectors sizes 25mm and larger.

.4 Couplings and connectors for PVC rigid conduit shall be CSA approved for their respective use. All PVC fittings shall be solvent weld type. Push-fit fittings are not acceptable.

.5 Connectors for flexible conduit and armoured cable shall be set-screw steel. Locknuts shall be case hardened.

.6 Connectors for liquid tight flexible conduit shall be watertight, compression type galvanized steel or aluminum. Locknuts shall be case hardened.

.7 Galvanized rigid steel couplings shall be used with all rigid steel threaded conduit.

2.4 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION – GENERAL

.1 Install conduits to conserve headroom and cause minimum interference in spaces through which they pass.
  .1 Conduits are to be installed as high as possible to underside of structure.

.2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.3 Use electrical metal tubing (EMT) for all work, unless otherwise indicated, for panelboard feeders, branch circuit wiring, etc., and where not installed underground.

.4 Rigid PVC conduits or rigid galvanized steel threaded conduit shall be used in all poured concrete construction.

.5 Use rigid PVC conduit underground.

.6 All PVC rigid conduits prior to exiting concrete slabs where exposed are to be adapted from PVC conduit to rigid galvanized conduit elbow, with the transition to take place in the slab or below grade.

.7 Use rigid galvanized steel threaded conduit for branch circuits in hazardous areas.

.8 Use epoxy coated conduit in corrosive areas.

.9 Use flexible metal conduit for connections to mechanical controls equipment such as VAV Boxes and their respective junction boxes, and where rigid EMT conduit cannot be used, such as cabinet work.

.10 Use liquid tight flexible metal conduit for connections transformers, motors and equipment in both wet and dry areas.

.11 Use explosion proof flexible connection for connection to explosion proof motors.

.12 Install conduit sealing fittings in hazardous areas. Fill with compound.

.13 Minimum conduit size for lighting and power circuits:12mm.

.14 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.15 Mechanically bend steel conduit over 19mm dia.

.16 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.17 Install fish cord in empty conduits.

.18 Run two 25mm spare conduits up to ceiling space and two 25mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152mm x 152mm x 102mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.

.19 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.20 Dry conduits out before installing wire.

.21 Securely fasten in place within 914mm of each outlet box, junction box, cabinet, coupling or fitting, maximum spacing between supports as follows:
- .1 1.5m for 12mm and 19mm EMT.
- .2 2.1m for 25mm and 25mm EMT.
- .3 3.0m for 12mm EMT and larger.

.22 Water-tight EMT connectors shall be used on "vertical" sections of conduit runs where terminating into tops of electrical equipment incorporating drip shields or hoods.

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Run conduits in flanged portion of structural steel.

.3 Group conduits wherever possible on suspended or surface channels.

.4 Do not pass conduits through structural members except as indicated.

.5 Do not locate conduits less than 76mm parallel to steam or hot water lines with minimum of 25mm at crossovers.

3.3 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials, components and installation procedures for dry type transformers up to 600V primary.

1.2 RELATED SECTIONS

.1 None.

1.3 REFERENCES

.1 American National Standards Institute (ANSI) latest edition of the following:
  - .1 ANSI/ASA Z55.1, Gray Finishes for Industrials Apparatus and Equipment.

.2 Canadian Standards Association (CSA International) Latest Edition of the following:
  - .1 CSA C22.2 No. 47, Air-Cooled Transformers (Dry Type).
  - .2 CSA C9, Dry-Type Transformers.
  - .3 CAN/CSA-C802.2 Minimum Efficiency Values for Dry-Type Transformers.

.3 National Electrical Manufacturers Association (NEMA) latest edition of the following
  - .1 NEMA ST 20, Dry Type Transformers for General Applications.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop Drawings:
  - .1 Indicate materials, finish, dimensions and installation details.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for dry-type transformers for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

.2 Operation and maintenance instructions to include:
  - .1 Tap changing.
  - .2 Recommended environmental conditions.
  - .3 Recommended periodic inspection and maintenance.

Part 2 Products

2.1 MANUFACTURERS

.1 Subject to compliance with requirements, provide products by the following:
  - .1 Hammond
  - .2 Eaton

.3 Siemens
.4 Delta
.5 REX

2.2 TRANSFORMERS

.1 Dry-type transformers: to CAN/CSA-C22.2 No.47, CSA-C9, and CSA C802.2. Use transformers of one manufacturer throughout project.

.2 Characteristics, Design 1 – General Purpose:
.1 Type: ANN.
.2 Rating: as indicated on drawings, 3 phase, 60 Hz.
.3 220 degrees C insulation class, 150 degrees C temperature rise.
.4 Impedance:
.1 Up to 150 kVA: 4 - 6.5%.
.2 225 - 300 kVA: 4 - 8 %.
.5 Primary and secondary coils: Copper.
.6 Primary winding: 600V, delta, BIL 10kV.
.7 Secondary winding: 208/120V, wye, BIL 10kV, four wire with neutral brought out and grounded.
.8 Sound rating: to CSA C9, NEMA ST 20.
.9 Voltage taps: 4-2.5%, 2-FCAN, 2-FCBN.
.10 Enclosure:
.1 Sheet steel fabrication.
.2 CSA Type 1 c/w sprinkler hoods.
.3 Bolted removable panels for access to tap connections and enclosed terminals.
.4 Designed for floor mounting for all sizes. Designed for wall or floor mounted for sizes up to 50 kVA.
.5 Indoor, ventilated self-cooled type. Temperature of exposed metals parts no to exceed 65 degrees C rise.
.6 Finish: ANSI 61 light grey.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Equipment labels: nameplate size 7.

.3 Nameplate wording: Transformer No., Source, Equipment fed.

Part 3 Execution

3.1 INSTALLATION

.1 Locate, install and ground transformers as indicated and in accordance with manufacturer's instructions.

.2 Mount transformers up to 50 kVA as indicated. Floor mounted transformers shall be mounted on a concrete housekeeping pad.

.3 Mount transformers above 50 kVA on floor, on a concrete housekeeping pad.

.4 Housekeeping pad shall be rigid, plumb and square to build floor and wall(s), 152mm larger than the outside dimensions of the equipment they support, not less than 102mm thick, and be complete with chamfered edges.

.5 Ensure adequate clearance around transformer for ventilation, locate units at least 152mm from adjacent walls and/or structures.

.6 Set and secure transformers in place, rigid plumb and square. Loosen isolation pad bolts until no compression is visible.

.7 Make primary and secondary connections in accordance with wiring diagram. Use flexible conduit to make connections to transformer.

.8 Energize transformers after installation is complete.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 The following tests shall be performed as standard on all transformers:
- .1 Ratio tests at the rated voltage connection and at all tap connections.
- .2 Polarity and phase relation tests on the rated voltage connection.
- .3 Applied potential tests.
- .4 Induced potential test.
- .5 No-load and excitation current at rated voltage on the rated voltage connection.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work results – Electrical.

.2 Section 26 28 16 – Moulded Case Circuit Breakers.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
   .1 CSA C22.2 No. 29, Panelboards and Enclosed Panelboards.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop drawings:
   .1 Indicate electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

Part 2 Products

2.1 PANELBOARDS

.1 Acceptable manufacturers:
   .1 Siemens.
   .2 Eaton.
   .3 Schneider.

2.2 PANELBOARDS

.1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.
   .1 Install circuit breakers in panelboards before shipment.
   .2 In addition to CSA requirements, manufacturer's nameplate must show fault current that panel, including breakers has been built to withstand.

.2 250 V and 600 V panelboards: bus and breakers rated for 22 kA (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Fitted with lock type doors and two (2) keys for each panelboard and key panelboards alike.

.6 Copper bus or tin plated aluminium with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 Provide bonding terminal strips in panelboards, factory installed. Where more than one bonding terminal strip is present in any one panel, both shall be hard-wired together using identical size bonding conductor as one accompanying the panel feeder conductors.

.9 Trim with concealed front bolts and hinges.

.10 Trim and door finish: baked grey enamel.

.11 Surface mounted panel shall be complete with sprinkler-proof hoods.

.12 Panelboards shall be a minimum of 508mm wide. Distribution panels with mains larger than 225 A shall be a minimum of 965mm wide x 279mm deep.

2.3 BREAKERS

.1 Breakers: to Section 26 28 16 – Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.4 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit. Directory shall be protected by a clear plastic cover.

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 11 – Rough Carpentry. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height specified in Section 26 05 00 – Common Work Results - Electrical or as indicated.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

3.2 TESTS

.1 Test each branch breaker to verify that it controls the load indicated on the drawing and panel directory.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures for switches, receptacles, wiring devices, and cover plates.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
  .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations
  .2 CSA C22.2 No. 42, General Use Receptacles, Attachment Plugs and Similar Devices.
  .3 CSA C22.2 No. 42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  .4 CSA C22.2 No. 55, Special Use Switches.
  .5 CSA C22.2 No. 111, General-Use Snap Switches (Bi-national standard, with UL 20).

.2 National Electrical Manufacturers Association (NEMA).

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

Part 2 Products

2.1 SWITCHES

.1 15 A and 20 A, 120 V and 347 V, single pole, three-way, and four-way switches to: CSA C22.2 No. 55 and CSA C22.2 No. 111.

.2 Manually-operated general purpose AC switches fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads with the following features:
  .1 Terminal holes approved for #10 AWG wire.
  .2 Silver alloy contacts.
  .3 Impact resistant nylon face and thermoplastic back body.
  .4 Suitable for back and side wiring.
  .5 White toggle.

.3 Acceptable manufacturers:
  .1 15 A, 120 V, single pole:
    .1 Hubbell No. HBL1201W.
    .2 Pass & Seymour No. PS15AC1W.
    .3 Leviton No. 1201-2W
  .2 20 A, 120 V, single pole:
    .1 Hubbell No. HBL1221W.
    .2 Pass & Seymour No. PS20AC1W.
    .3 Leviton No. 1221-2W
  .3 15 A, 347 V, single pole:
    .1 Hubbell No. HBL18201WCN.
    .2 Pass & Seymour No. PS371510W.
    .3 Leviton No. 18201-W
  .4 20 A, 347 V, single pole:
    .1 Hubbell No. HBL18221WCN.
    .2 Pass & Seymour No. PS372010W.
    .3 Leviton No. 18221-W

.4 Three-way and four-way switches of same standard quality.

.5 Other switches with ampacity, voltage, and features as indicated.

.6 Switches of one manufacturer throughout project

.7 Construction series switches are not acceptable.

2.2 RECEPTACLES

.1 15 A and 20, 125 V, U-ground, duplex receptacles (CSA type 5-15R and 5-20R respectively): to CSA C22.2 No. 42 with following features:
  .1 Impact resistant nylon face and thermoplastic back body.
  .2 Suitable for #10 AWG for back and side wiring.
  .3 Break-off links for use as split receptacles.
  .4 Eight back wired entrances, four side wiring screws.
  .5 Triple wipe contacts and rivetted grounding contacts.

.2 Acceptable Manufacturers:
  .1 15 A, 125 V (CSA 5-15R), duplex receptacle:
    .1 Hubbell No. HBL5262W.
    .2 Pass & Seymour No. PS5262W
    .3 Leviton No. 5262-W
  .2 20 A, 125 V (CSA 5-20R), duplex receptacle:
    .1 Hubbell No. HBL5362W.
    .2 Pass & Seymour No. PS5362W
    .3 Leviton No. 5362-W

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles of one manufacturer throughout project.

.5 Construction series receptacles are not acceptable.

2.3 COVER PLATES

.1 Cover plates for wiring devices: to CSA C22.2 No. 42.1.
  .1 Impact resistant nylon, colour to match wiring device, for wiring devices mounted in flush-mounted outlet box.

.2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.4 Weatherproof while-in-use cover for exterior wiring devices:
  .1 Extra-duty, die-cast aluminum construction, padlockable, NEMA 3R rated, to comply with CSA C22.1.

.5 Cover plates from one manufacturer throughout project.

2.4 IDENTIFICATION

.1 All receptacles facility are to each have individual lamicoid nameplate installed on cover plate directly above receptacle, with the following information: designated panel numbers and/or letters, circuit no(s). and any other information as may be deemed necessary

.2 Provide size 1 nameplate in accordance with Section 26 05 00 – Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

.1 Switches:
  .1 Install single throw switches with toggle in "UP" position when switch closed.
  .2 Install switches in gang type outlet box when more than one switch is required in one location.
  .3 Mount toggle switches at height in accordance with Section 26 05 00 – Common Work Results - Electrical or as indicated otherwise.

.2 Receptacles:
  .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  .2 Mount receptacles at height in accordance with Section 26 05 00 – Common Work Results - Electrical or as indicated otherwise.
  .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.3 Cover plates:
- .1 Protect cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .4 Install weatherproof while-in-use cover plates for all receptacles exposed to the weather.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures of low voltage fuses.

1.2 RELATED SECTIONS

.1 None.

1.3 REFERENCES

.1 Canadian Standards Association (CSA) latest edition of the following:
  - .1 CSA C22.2 No. 248.12, Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248).

.2 Underwriter's Laboratory (UL).

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

.2 Provide fuse performance data characteristics for each fuse type and size above 100 A. Performance data to include: average melting time-current characteristics.

1.5 DELIVERY AND STORAGE

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Store fuses in original containers in storage cabinet.

1.6 MAINTENANCE MATERIALS

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

.2 Provide three (3) spare fuses of each type and size installed above 600 A.

.3 Provide six (6) spare fuses of each type and size installed up to and including 600 A.

Part 2 Products

2.1 FUSES – GENERAL

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer for entire project.

2.2 FUSE TYPES

.1 Class L fuses (formerly HRC-L):
  .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  .2 Type L2, fast acting.

.2 Class J fuses (formerly HRCI- J):
  .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  .2 Type J2, fast acting.

.3 Class R -R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and its’ peak let-through values not to exceed limits of UL 198E, table 10.2.
  .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
  .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.4 Class C fuses (formerly HRCII- C).

2.3 FUSE STORAGE CABINET

.1 Fuse storage cabinet, manufactured from12 gauge thick, 30" high x 24" wide x 12" deep hinged, lockable front access door.

Part 3 Execution

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.
  .1 Install rejection clips for Class R fuses.

.3 Ensure correct fuses fitted to assigned electrical circuit.

.4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

.5 Fuses for motor loads shall be of the time-delay type

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers.

1.2 RELATED SECTIONS

.1 Section 26 24 16 – Panelboards Breaker Type.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
  .1 CSA-C22.2 No. 5, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.

.2 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 22 kA symmetrical (rms) and over at system voltage.

Part 2 Products

2.1 MANUFACTURERS

.1 Breakers shall be compatible with service entrance board and panelboards specified in 26 24 16 – Panelboards Breaker Type and shall meet the kA ratings as indicated.

2.2 BREAKERS – GENERAL

.1 Moulded-case circuit breakers, and accessory high-fault protectors: to CSA C22.2 No. 5.

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 104°F (40 °C) ambient.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.4 Common-trip breakers: with single handle for multi-pole applications. Tie-bars are not permitted.

.5 The use of plug-in moulded-case circuit breakers is not permitted.

.6 The use of “mini” type circuit breakers is not permitted.

.7 Extension handles are to be provided for all breakers rated 225 A and larger.

2.3 THERMAL MAGNETIC BREAKERS

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.4 SOLID STATE TRIP BREAKERS

.1 Moulded-case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous, tripping for phase, and ground fault short circuit protection.

.2 Main breaker for service entrance board shall be solid-state, rated for 100% current carrying capacity.

.3 All breakers 400 A and large shall be solid state.

2.5 OPTIONAL FEATURES

.1 Include, as indicated:
- .1 Shunt trip.
- .2 Auxiliary switch.
- .3 Motor-operated mechanism.
- .4 Under-voltage release.
- .5 On-off locking device.
- .6 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures for fused and non-fused disconnect switches.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results – Electrical.

.2 Section 26 28 13 – Fuses - Low Voltage.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
- .1 CAN/CSA C22.2 No. 4, Enclosed and Dead-Front Switches (Tri-National standard, with ANCE NMX-J-162-2004 and UL 98).
- .2 CSA C22.2 No. 39, Fuseholder Assemblies.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Fusible, non-fusible, horsepower rated disconnect switch in CSA enclosure type as indicated, to CAN/CSA C22.2 No. 4, size as indicated.

.2 Provision for padlocking switch in either ON or OFF positions.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Fuses: size as indicated, in accordance with Section 26 28 13 – Fuses - Low Voltage.

.5 Fuseholders: to CSA C22.2 No. 39, relocatable and suitable without adaptors, for type and size of fuse indicated.

.6 Quick-make, quick-break action.

.7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Nameplate size: 4.

.3 Nameplate wording: Equipment designation, source, voltage and number of phases.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable, where indicated.

3.2 TESTING

.1 Operate each disconnect switch to verify that the loads are disconnected.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation procedures for loose mounted starters.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International) latest edition of the following:
- .1 CSA C22.1, Canadian Electrical Code, Part 1), Safety Standard for Electrical Installations.
- .2 CSA C22.2 No. 14, Industrial Control Equipment

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.2 Indicate:
- .1 Mounting method and dimensions.
- .2 Starter size and type.
- .3 Layout of identified internal and front panel components.
- .4 Enclosure types.
- .5 Wiring diagram for each type of starter.
- .6 Interconnection diagrams.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

.2 Include operation and maintenance data for each type and style of starter.

Part 2 Products

2.1 MANUFACTURERS

.1 The following are acceptable manufacturers:
- .1 Siemens.
- .2 Eaton.
- .3 Schneider.
- .4 Allen Bradley.

2.2 MATERIALS

.1 Starters: to CSA C22.2 No. 14.

.2 Half size starters are not acceptable.

2.3 MANUAL MOTOR STARTERS

.1 Single and three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  .1 Switching mechanism, quick make and break.
  .2 One (1) or three (3) overload heaters, manual reset, trip indicating handle.

.2 Accessories:
  .1 Toggle switch: heavy duty, labelled as indicated.
  .2 Indicating light: LED type, green.
  .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 FULL VOLTAGE MAGNETIC STARTERS

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  .1 Contactor solenoid operated, rapid action type.
  .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  .3 Wiring and schematic diagram inside starter enclosure in visible location.
  .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
  .5 Power and control terminals.
  .6 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:
    .1 Locking in "OFF" position with up to 3 padlocks.
    .2 Independent locking of enclosure door.
    .3 Provision for preventing switching to "ON" position while enclosure door open.
  .7 Starters for motors rated 5 HP and larger shall have single phase protection.

.2 Accessories:
  .1 Pushbuttons and selector switches: standard, labelled as indicated.
  .2 Indicating lights: LED type, GREEN for running, RED for stopped.
  .3 4-N/O and 4-N/C spare auxiliary contacts unless otherwise indicated.
  .4 Current sensing relays.

2.5 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.6 CURRENT SENSING RELAY

.1 All starters shall be complete with current sensing relays.

.2 Coordinate materials and installation with EMCS contractor.

2.7 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 – Common Work Results - Electrical.

2.8 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Identify manual starters:
  .1 Nameplate size: 1.
  .2 Nameplate wording: Equipment designation, source, voltage and number of phases.

.3 Identify magnetic starters and variable speed drives (VSD):
  .1 Nameplate size: 3.
  .2 Nameplate wording: Equipment designation, source, voltage and number of phases.

Part 3 Execution

3.1 INSTALLATION

.1 Install starters and control devices in accordance with manufacturer’s instructions.

.2 Install and wire starter and controls as indicated.

.3 Ensure correct fuses and overload devices elements installed.

.4 Confirm corresponding motor nameplate and adjust overload device to suit.

.5 Mounting:
  .1 On wall in accordance with CAN/CSA C22.1.
  .2 If there is no available wall space, contractor shall build support structure (e.g. uni-strut rack) to mount starters, including variable speed drives (supplied by Mechanical Controls Contractor).

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical, and manufacturer's instructions.

.2 Operate switches and contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association, (CSA International) latest edition of the following:
- .1 CSA C22.2 No. 178.1, Transfer Switch Equipment (Tri-national standard, with NMX-J-672 ANCE and UL 1008).
- .2 CSA C282, Emergency Electrical Power Supply for Buildings.
- .3 CAN/CSA-C60044, Instrument Transformers

.2 American National Standards Institute (ANSI)/National Electrical Manufacturers Association (NEMA) latest edition of the following:
- .1 ANSI/NEMA ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

.3 International Organization for Standardization (ISO) latest edition of the following:
- .1 ISO 9001, Quality Management Systems - Requirements.

1.4 DESCRIPTION OF SYSTEM

.1 Automatic load transfer equipment to:
- .1 Monitor voltage on phases of normal power supply. The transfer switch shall operate as a conventional break-before-make (open transition) switch when the power source serving the load fails.
- .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
- .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
- .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
- .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.2 Include:
  .1 Make, model and type.
  .2 Load classification.
  .3 Single line diagram showing controls and relays.
  .4 Description of equipment operation including:
    .1 Automatic starting and transfer to standby unit and back to normal power.
    .2 Test control.
    .3 Manual control
    .4 Automatic shutdown.

1.6 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

.2 Detailed instructions to permit effective operation, maintenance and repair.

.3 Technical data:
  .1 Schematic diagram of components, controls and relays.
  .2 Illustrated parts lists with parts catalogue numbers.
  .3 Certified copy of factory test results.

.4 Provide final testing report to the Departmental Representative with letter certifying the installation.

1.7 QUALITY ASSURANCE

.1 The ATS manufacturer shall be certified to ISO 9001 and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

Part 2 Products

2.1 AUTOMATIC TRANSFER SWITCH (ATS)

.1 Subject to compliance with requirements, provide products by the following:
  .1 ASCO.
  .2 Kohler.
  .3 Cummins.
  .4 Caterpillar.

2.2 AUTOMATIC TRANSFER SWITCH (ATS)

.1 The automatic transfer switch shall:
  .1 Conform to the requirements of CSA C22.2 No. 178.1.
  .2 Be suitable for use in emergency and standby systems.
  .3 Ratings: 600/347V, amperage as indicated.
  .4 Fault withstand rating: 22 kA.

.2 The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

.3 All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

.4 The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

.5 All main contacts shall be of silver composition.

.6 Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

.7 Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

.8 Where neutral conductors must be switched, the ATS shall be provided with fully- rated neutral transfer contacts.

.9 Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.3 BYPASS-ISOLATION SWITCH

.1 Provide ATS with a bypass-isolation switch where indicated.

.2 A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.

.3 Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control inter-wiring shall be provided with disconnect plugs.

.4 Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.

.5 Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

.6 The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

.7 When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

.8 Designs requiring operation of key interlocks for bypass isolation or transfer switches which cannot be completely withdrawn when isolated are not acceptable.

2.4 MICROPROCESSOR CONTROLLER

.1 The controller’s sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate through the communications interface.

.2 A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 degrees C to +60 degrees C and storage from -55 degrees C to +85 degrees C.

.3 The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator’s manuals.

.4 All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

.5 The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

- .1 IEC 60947-6-1, Multiple Function Equipment - Transfer Switching Equipment.
- .2 IEC 61000-4-1, Electromagnetic Compatibility (EMC) - Part 4-1: Testing and Measurement Techniques - Overview of Immunity Tests.

.3 IEC 61000-4-2, Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test.
.4 IEC 61000-4-3, Electromagnetic Compatibility (EMC) - Part 4-3: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test.
.5 IEC 61000-4-4, Electromagnetic Compatibility (EMC) - Part 4-4: Testing and Measurement Techniques - Electrical Fast Transient/Burst Immunity Test.
.6 IEC 61000-4-5, Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test.
.7 IEC 61000-4-6, Electromagnetic Compatibility (EMC) - Part 4-6: Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields.

2.5 ENCLOSURE

.1 The ATS shall be furnished in a type 1 enclosure unless otherwise indicated.

.2 All standard and optional door-mounted switches and pilot lights shall be 5/8" industrial grade type or equivalent for easy viewing and replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

2.6 OPERATION

.1 Controller Display and Keypad:
.1 A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the communications interface. The following parameters shall only be adjustable via DIP switches on the controller:
.1 Nominal line voltage and frequency
.2 Single or three phase sensing
.3 Operating parameter protection
.4 Transfer operating mode configuration (Open transition, Closed transition, or Delayed transition)
.2 All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

.2 Voltage, Frequency and Phase Rotation Sensing:
.1 Voltage and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities:

Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N & E	70 to 98 %	85 to 100 %
Overvoltage	N & E	102 to 115 %	2% below trip
Underfrequency	N & E	85 to 98 %	90 to 100 %
Overfrequency	N & E	102 to 110 %	2% below trip

.2 Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20 degrees C to 60 degrees C.
.3 Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via communications interface access.

.4 The controller shall be capable (when activated by the keypad or through the communications interface) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

.5 Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

.6 The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye – Grounded Wye transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the controller keypad and LCD.

.3 Time delays:

.1 An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

.2 A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

.3 Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

.4 A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

.5 A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

.1 Prior to transfer only.

.2 Prior to and after transfer.

.3 Normal to emergency only.

.4 Emergency to normal only.

.5 Normal to emergency and emergency to normal.

.6 All transfer conditions or only when both sources are available.

.6 All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

.7 All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the communications interface.

2.7 ADDITIONALL FEATURES

.1 A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

.2 Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source. The auxiliary contacts shall be equal to ASCO Accessory 14A/14B.

.3 Two-pole, double-throw contacts, rated 10 amps, 120 VAC, shall be provided to operate when emergency source voltage is present at transfer switch terminals. The auxiliary contacts shall be equal to ASCO Accessory 18B.

.4 Two-pole, double-throw contacts, rated 10 amps, 120 VAC, shall be provided to operate when normal source voltage is present at transfer switch terminals. The auxiliary contacts shall be equal to ASCO Accessory 18G.

.5 Two-pole, double-throw contacts, rated 3 amps, 480 VAC shall be provided to operate after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer. This contact can be used to selectively disconnect specific load(s) when the transfer switch is transferred. The auxiliary contacts shall be equal to ASCO Accessory 31Z.

.6 LED indicating lights (16mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

.7 Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

.8 An inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.

.9 Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
- .1 Enable or disable the routine.
- .2 Enable or disable transfer of the load during routine.
- .3 Set the start time:
  - .1 Time of day.
  - .2 Day of week.
  - .3 Week of month (1st, 2nd, 3rd, 4th, alternate or every).
- .4 Set the duration of the run.
- .5 At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10 year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

.10 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or communications interface.

.11 Ethernet Connectivity Module - A communications interface shall be installed in the ATS controller to provide 100 Mbps ethernet connectivity for transfer switches and power meters. It shall include AES 128-bit encryption, as per NSIT, for enhanced security. This module offers communication to transfer switch and metering with embedded webpages. The ethernet connectivity module shall be equal to ASCO Accessory 72E.

2.8 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Nameplate size: 6.

.3 Nameplate wording: Equipment designation, equipment rating (in amps), voltage, number of phases, and equipment fed.

.4 Control panel:
  - .1 For selector switch and manual switch: size 4 nameplates.
  - .2 For meters, indicating lights, minor controls: size 2 nameplates.

Part 3 Execution

3.1 INSTALLATION

.1 Locate, install and connect transfer equipment.

.2 Check relays and solid state monitors and adjust as required.

.3 Install and connect battery and remote alarms.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Energize transfer equipment from normal power supply.

.3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

.4 Set selector switch in "Manual" position and check to ensure proper performance.

.5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.

.6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.

.7 Repeat, at 1h intervals, 4 times, complete test with selector switch in each position, for each test.

3.3 TRAINING

.1 Provide familiarization training to operating and maintenance staff in accordance with Section 01 78 00 – Closeout Submittals.

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

END OF SECTION