Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments
Canada

CFIA BURNABY LAB – REPLACEMENT OF AIR HANDLER 301

SPECIFICATIONS

ISSUED FOR TENDER

PREPARED FOR:

CFIA BURNABY LAB
3155 WILLINGDON GREEN,
BURNABY, BC

SEPTEMBER 15, 2016

PREPARED BY: WSP CANADA INC.

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WSP

Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises renovation of Canadian Food Inspection Agency (CFIA) Burnaby Laboratory located at 3155 Willington Green, Burnaby, British Columbia V5G 4P2 and further identified as AHU-301 Replacement.

1.2 CONTRACT METHOD

.1 Construct Work under stipulated price contract.

.2 Refer to front end documents.

1.3 WORK BY OTHERS

.1 Co-operate with other Contractors in carrying out their respective works and carry out instructions from Consultant.

.2 Co-ordinate work with that of other Contractors. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Consultant, in writing, any defects which may interfere with proper execution of Work.

1.4 WORK SEQUENCE

.1 Construct Work in stages to accommodate Owner's continued use of premises during construction.

.2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.

.3 Construct Work in stages to accommodate Owner’s continuous public usage. Do not close off public usage of facilities until use of one stage of Work will provide alternate usage.

.4 Required stages:

.1 All new work, demolition, and commissioning must be performed and completed allowing a one week shutdown for removal of existing AHU-301 and replacement of new AHU-301.

.2 Order new factory AHU-301 complete with integral controls and factory commissioning. Provide HEPA filter leak testing in factory.

.3 The existing penthouse wall panels adjacent to existing AHU-301 are to be removed to allow access to remove existing AHU-301 and install new factory built AHU-301. Provide waterproof and airtight hoarding in open wall area

.4 Remove demolished materials not affecting existing AHU-301 operation. The existing glycol heat recovery system can be removed.

.5 Install and commission new humidifier, DI water supply pump and other new work in preparation for new AHU-301 installation.

.6 Remove existing AHU-301 and install AHU-301 complete with new piping, ductwork, electrical, commissioning. The shutdown period for this sequence is one week.

.7 Provide commissioning and reports verifying operation of new AHU-301, humidifiers, pumps and associated equipment.

.8 Provide HEPA filter leak testing of AHU-301 on site.

.9 Correct any deficiencies.

.10 Replace penthouse wall panels.

.5 Maintain fire access/control.

.6 HVAC systems shall be kept operational at all times unless scheduled by Owner for one week shutdown of AHU-301 and tie-in of new systems.

1.5 CONTRACTOR USE OF PREMISES

.1 Unrestricted use of site until Substantial Performance.

.2 Limit use of premises for Work to allow:

.1 Owner occupancy.

.2 Work by other contractors.

.3 Public usage.

.3 Co-ordinate use of premises under direction of Owner.

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

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

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

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

1.6 OWNER OCCUPANCY

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

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

1.7 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 Consultant and Owner to facilitate execution of work.

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

.1 Protect walls of passenger elevators to approval of Consultant prior to use.

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

1.8 DOCUMENTS REQUIRED

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

- .1 Contract Drawings.
- .2 Specifications.
- .3 Addenda.
- .4 Reviewed Shop Drawings.
- .5 List of Outstanding Shop Drawings.
- .6 Change Orders.
- .7 Other Modifications to Contract.
- .8 Field Test Reports.
- .9 Copy of Approved Work Schedule.
- .10 Health and Safety Plan and Other Safety Related Documents.
- .11 Other documents as specified.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

1.2 ACCESS AND EGRESS

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

1.3 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated. Normal office and laboratory functions must be maintained at all times. Therefore contractor work in offices and laboratories must take place at night.

.2 Maintain existing services to building and provide for personnel and vehicle access.

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

.4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.

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

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

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

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

.7 Opening in penthouse wall shall be covered with airtight plastic hoarding during construction.

1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.5 EXISTING SERVICES

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

.2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.

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

1.6 SPECIAL REQUIREMENTS

.1 Carry out noise generating Work Monday to Friday as per Department Representative requirements.

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

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

.4 Deliver materials outside of peak traffic hours as per Departmental Representative indicates.

1.7 SECURITY

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

.2 Security clearances:

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

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

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

.4 Contractor's personnel will require satisfactory RCMP initiated security screening in order to complete Work in premises and on site.

.3 Security escort:

.1 Personnel employed on this project must be escorted when executing work in non-public areas during normal working hours. Personnel must be escorted in all areas after normal working hours.

.2 Submit an escort request to Departmental Representative at least 14 days before service is needed. For requests submitted within time noted above, costs of security escort will be paid for by Departmental Representative. Cost incurred by late request will be Contractor's responsibility.

.3 Any escort request may be cancelled free of charge if notification of cancellation is given at least 4 hours before scheduled time of escort. Cost incurred by late request will be Contractor's responsibility.

1.8 BUILDING SMOKING ENVIRONMENT

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

1.9 Existing Building HVAC Systems

.1 Existing building HVAC systems must remain operational during staff working hours.

1.10 Night time / Overtime Work

.1 The cost of all night time and overtime work by the contractor is to be included in the contractors' price and bid.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

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

.2 Prepare agenda for meetings.

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

.4 Provide physical space and make arrangements for meetings.

.5 Preside at meetings.

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

.7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants Departmental Representative

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

1.2 PRECONSTRUCTION MEETING

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

.2 Departmental Representative, Consultant, Contractor and major Subcontractors will be in attendance.

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

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

.5 Agenda to include:

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

.2 Schedule of Work

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

.4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences.

.5 Delivery schedule of specified equipment.

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

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

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

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

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

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

.12 Appointment of inspection and testing agencies or firms.

.13 Insurances, transcript of policies.

1.3 PROGRESS MEETINGS

.1 During course of Work and bi- monthly.

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

.3 Notify parties minimum 7 days

.4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 2 days

.5 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of Work progress since previous meeting.

.3 Field observations, problems, conflicts.

.4 Problems which impede construction schedule.

.5 Review of off-site fabrication delivery schedules.

.6 Corrective measures and procedures to regain projected schedule.

.7 Revision to construction schedule.

.8 Progress schedule, during succeeding work period.

.9 Review submittal schedules: expedite as required.

.10 Maintenance of quality standards.

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

.12 Other business.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Submit to Consultant submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

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

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Shop drawings shall be complete and include all equipment in each category.

.7 Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.8 Verify field measurements and affected adjacent Work are co-ordinated.

.9 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.

.10 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant’s review.

.11 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.

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

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

.5 Adjustments made on shop drawings by the Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.

.6 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter, in duplicate, containing:

- .1 Date.
- .2 Project title and number.
- .3 Contractor's name and address.
- .4 Identification and quantity of each shop drawing, product data and sample.
- .5 Other pertinent data.

.8 Submissions include:

- .1 Date and revision dates.
- .2 Project title and number.
- .3 Name and address of:
  - .1 Subcontractor.
  - .2 Supplier.
  - .3 Manufacturer.
- .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
- .5 Details of appropriate portions of Work as applicable:
  - .1 Fabrication.
  - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
  - .3 Setting or erection details.
  - .4 Capacities.
  - .5 Performance characteristics.
  - .6 Standards.
  - .7 Operating weight.
  - .8 Wiring diagrams.
  - .9 Single line and schematic diagrams.
  - .10 Relationship to adjacent work.

.9 After Consultant's review, distribute copies.

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

.11 Submit electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Consultant.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

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

.13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Consultant.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of project contract complete with project name.

.14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Consultant.

.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

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

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

.16 Submit 3 electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant.

.17 Delete information not applicable to project.

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

.19 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.20 The review of shop drawings by the Consultant is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that the Consultant approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

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

.2 Deliver samples prepaid to Consultant's business address.

.3 Notify Consultant 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 Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.

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

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

1.4 CERTIFICATES AND TRANSCRIPTS

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

.2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.2 Province of British Columbia

.1 Workers Compensation Act, RSBC 1996 - Updated 2012.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:

.1 Results of site specific safety hazard assessment.

.2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.

.3 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to authority having jurisdiction and Consultant.

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

.5 Submit copies of incident and accident reports.

.6 Submit WHMIS MSDS - Material Safety Data.

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

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

.9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Consultant.

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

1.3 FILING OF NOTICE

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

.2 Contractor shall be responsible and assume the Principal Contractor role for each work zone location and not the entire complex. Contractor shall provide a written acknowledgement of this responsibility with 3 weeks of contract award. Contractor to submit written acknowledgement to CSST along with Ouverture de Chantier Notice.

.3 Work zone locations include:

.1 Specific areas to be designated by client.

.4 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.

1.4 SAFETY ASSESSMENT

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

1.5 MEETINGS

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

1.6 REGULATORY REQUIREMENTS

.1 Do Work in accordance with Section 01 14 00 – Work Restrictions.

1.7 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:

.1 Site maintenance staff

.2 CFIA department representative

.3 Consultant

1.8 GENERAL REQUIREMENTS

.1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

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

1.9 RESPONSIBILITY

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

.2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.10 COMPLIANCE REQUIREMENTS

.1 Comply with Workers Compensation Act, B.C. Reg.

.2 Comply with R.S.Q., c. S-2.1, an Act respecting Health and Safety, and c. S-2.1, r.4 Safety Code for the Construction Industry.

.3 Comply with Occupational Health and Safety Regulations, 1996.

.4 Comply with Occupational Health and Safety Act, General Safety Regulations, O.I.C.

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

1.11 UNFORSEEN HAZARDS

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

.2 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise Health and Safety co-ordinator and follow procedures in accordance with Acts and Regulations of B.C. having jurisdiction and advise Consultant verbally and in writing.

1.12 HEALTH AND SAFETY CO-ORDINATOR

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

.1 Have site-related working experience specific to activities associated with operational labs.

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

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

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

.5 Be on site during execution of Work and report directly to and be under direction of Registered Occupational Hygienist Certified Industrial Hygienist.

1.13 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of B.C. having jurisdiction, and in consultation with Consultant.

1.14 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Consultant.

.2 Provide Consultant with written report of action taken to correct non-compliance of health and safety issues identified.

.3 Consultant may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 BLASTING

.1 Blasting or other use of explosives is not permitted without prior receipt of written instruction by Departmental Representative and Consultant.

1.16 POWDER ACTUATED DEVICES

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

1.17 WORK STOPPAGE

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

1.18 CFIA Safety Requirements

.1 All workers shall take CFIA safety orientation and comply with requirements.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 INSPECTION

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

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

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

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

1.2 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by Consultant for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Consultant.

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

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

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

1.3 ACCESS TO WORK

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

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

1.4 PROCEDURES

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

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

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

1.5 REJECTED WORK

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

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

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

1.6 REPORTS

.1 Submit 4 copies of inspection and test reports to Consultant.

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

1.7 EQUIPMENT AND SYSTEMS

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 10 14 00 Work Restrictions

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CGSB 1.59-[97], Alkyd Exterior Gloss Enamel.

1.3 INSTALLATION AND REMOVAL

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

.2 Remove from site all such work after use.

1.4 HOARDING

.1 Provide plastic airtight barriers around room equipment and penthouse wall openings. Protect from damage by equipment and construction procedures.

.2 Provide plywood hoarding around equipment exposed to work. Remove hoarding after night work to allow owner to occupy premises during the daytime.

1.5 DUST TIGHT SCREENS

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

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

1.6 FIRE ROUTES

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

1.7 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

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

.2 Be responsible for damage incurred.

1.8 PROTECTION OF BUILDING FINISHES

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

.2 Provide necessary screens, covers, and hoardings.

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

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 73 00 – Execution Requirements

1.2 QUALITY

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

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

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

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

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

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

1.3 AVAILABILITY

.1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

.2 In event of failure to notify Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.4 STORAGE, HANDLING AND PROTECTION

.1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.

.2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.

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

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

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

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

.7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

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

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

1.5 TRANSPORTATION

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

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

1.6 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

.2 Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.

.3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.

1.7 QUALITY OF WORK

.1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.

.2 Do not employ anyone unskilled in their required duties. Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.

.3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Consultant, whose decision is final.

1.8 CO-ORDINATION

.1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.

.2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.9 CONCEALMENT

.1 In finished areas conceal ducts and wiring in floors, walls and ceilings, except where indicated otherwise.

.2 Before installation inform Consultant if there is interference. Install as directed by Consultant.

1.10 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.

1.11 LOCATION OF FIXTURES

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

.2 Inform Consultant of conflicting installation. Install as directed.

1.12 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

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

.4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.

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

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

1.13 FASTENINGS - EQUIPMENT

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

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

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

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

1.14 PROTECTION OF WORK IN PROGRESS

.1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Consultant.

1.15 EXISTING UTILITIES

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

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

1.16 EXISTING CONDITIONS

.1 The work shall include the relocation of and/or connection to existing equipment, and ductwork as indicated. Make good equipment, insulation, and ductwork damaged or disturbed during the work to match existing. System shall be restored to match existing standards or as specified in this specification.

.2 Protect all existing services encountered. Arrange work to avoid shutdowns of existing services and offices and laboratory functions. Where interruptions are unavoidable, obtain approval for timing of shutdowns from owner and coordinate with authorities (i.e.., fire department) where fire protection services are interrupted.

.3 Drawings indicate general locations of existing services. Verify exact locations of services on site prior to fabrication of work.

.4 The Contractor shall attend a mandatory site visit to review the existing condition in order to comply with this Tender. Refer to the Instructions to Tenderers for date and address.

1.17 LIABILITY

.1 Assume responsibility for laying out work and for damage cause to the owner or others by improper execution of work.

.2 Protect finished and unfinished work from damage.

.3 Take responsibility for condition of materials and equipment supplied and protect until work is completed and accepted.

.4 Assume responsibility for demolition work and disposal of materials, equipment and services.

1.18 IDENTIFICATION

.1 Provide identification systems for materials used in mechanical systems which require control by Workplace Hazardous Materials Information System (WHMIS) issued by Occupational Safety and Health Division of Workers' Compensation Board of British Columbia in accordance with classification and application requirements of WHMIS standards for the following general categories.

.2 Provide safety data sheets and labels to WHMIS standards for materials required. Provide copy of safety data sheets in Mechanical Maintenance Manuals.

.3 Provide 20 mm diameter brass number tags or "Allflex" plastic tags with number stamped in black, secured to valve wheel with key chain for valves not in sight of apparatus controlled. Provide typewritten valve directory giving number, service and location.

.4 Tag automatic controls, electric switches, instruments and relays with lamicoid labels with 12 mm letters and key with control schematics.

.5 Provide lamicoid labels with 12 mm letters on equipment and motor starters.

1.19 FIRESTOPPING

.1 Work Included: Furnish labour, material, equipment and services necessary to provide firestopping and smoke seals around mechanical duct penetrations through fire-rated wall and floor assemblies to CSA Standard CAN3-S115-M85 and Authorities having jurisdiction.

.2 Work shall be carried out by approved specialist firm, employing tradesmen experienced in firestopping and smoke seal application. Installing Contractors shall be Certified by the British Columbia Insulation Contractors Association for work specified. Work shall be installed in accordance with manufacturer's recommended installation procedures.

.3 Acceptable Firestopping Systems:

.1 For Vertical Penetrations: 3M Fire Penetration Sealing System, BIO-Fire Protection Ltd. Frestopping and Smoke Seals, Dow Corning Firestop Sealant.

.2 For Horizontal and Poke-Through Penetrations: Fyre Sleeve and Fyre Flange as manufacturer by Frye Sleeve Industries Inc.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

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

- .1 Structural integrity of elements of project.
- .2 Integrity of weather-exposed or moisture-resistant elements.
- .3 Efficiency, maintenance, or safety of operational elements.
- .4 Visual qualities of sight-exposed elements.
- .5 Work of Owner or separate contractor.
- .6 Office and Laboratory functions

.3 Include in request:

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

1.2 MATERIALS

.1 Required for original installation.

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

1.3 PREPARATION

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

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

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

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

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

1.4 EXECUTION

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

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

.3 Uncover Work to install ill-timed Work.

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

.5 Remove samples of installed Work for testing.

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

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

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

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

.10 Fit Work airtight to ducts and other penetrations through surfaces.

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

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

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

1.2 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.

.2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.

.3 After working night times and weekends staff, work areas shall be free and clear to conduct daily laboratory and office functions.

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

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

.6 Provide and use marked separate bins for recycling.

.7 Dispose of waste materials and debris.

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

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

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

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

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

1.3 FINAL CLEANING

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

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

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

.4 Remove waste products and debris other than including that caused by Owner or other Contractors.

.5 Remove waste materials from site at regularly scheduled times or dispose of as directed by owner. Do not burn waste materials on site.

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

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

.8 Remove dirt and other disfiguration from exterior surfaces.

.9 Sweep and wash clean paved areas.

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

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

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

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

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

.2 Request Consultant's inspection.

.2 Consultant's Inspection:

.1 Consultant and Contractor to inspect Work and identify defects and deficiencies.

.2 Contractor to correct Work as directed.

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

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

.2 Defects: corrected and deficiencies completed.

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

.4 Operation of systems: demonstrated to Owner's personnel.

.5 Commissioning of mechanical systems: completed in accordance with 01 91 13 - General Commissioning Requirements and 4 copies of final Commissioning Report submitted to Consultant.

.6 Work: complete and ready for final inspection.

.4 Final Inspection:

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

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

.5 Declaration of Substantial Performance: when Consultant considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

.6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.

.7 Final Payment:

.1 When Consultant considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

.2 Refer to contract documents: when Work deemed incomplete by Consultant, complete outstanding items and request re-inspection.

.8 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

1.2 FINAL CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 45 00 – Quality Control

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

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

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

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

1.3 FORMAT

.1 Organize data as instructional manual.

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

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

.1 Identify contents of each binder on spine.

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

.5 Arrange content under Section numbers and sequence of Table of Contents.

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

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

.8 Drawings: provide with reinforced punched binder tab.

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

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

.10 Provide an electronic copy of manuals on CD.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

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

.1 Date of submission; names.

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

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

.2 For each product or system:

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

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

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

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

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

1.5 AS -BUILT DOCUMENTS AND SAMPLES

.1 Maintain, in addition to requirements in General Conditions, at site for Owner one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by Consultant.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of blue line opaque drawings, and in copy of Project Manual, provided by Consultant.

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

.3 Record information concurrently with construction progress.

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

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

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

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

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

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

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

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

.2 Changes made by Addenda and change orders.

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

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

1.7 EQUIPMENT AND SYSTEMS

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

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

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

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

.3 Include installed colour coded wiring diagrams.

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

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

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

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

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

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

.8 Include sequence of operation by controls manufacturer.

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

.10 Provide installed control diagrams by controls manufacturer.

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

.12 Include test and balancing reports as specified in Section 01 45 00 - Quality Control.

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

1.8 MATERIALS AND FINISHES

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

.2 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.

1.9 MAINTENANCE MATERIALS

.1 Spare Parts:

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

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

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Consultant.

.2 Include approved listings in Maintenance Manual.

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

.2 Special Tools:

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

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

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Consultant.

.2 Include approved listings in Maintenance Manual.

1.10 DELIVERY, STORAGE AND HANDLING

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

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

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

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

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Demonstrate operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.

.2 Owner: provide list of personnel to receive instructions, and co-ordinate their attendance at agreed-upon times.

.3 Preparation:

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

.2 Verify designated personnel are present.

.3 Ensure equipment has been inspected and put into operation.

.4 Ensure testing, adjusting, and balancing have been performed and equipment and systems are fully operational.

.4 Demonstration and Instructions:

.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the designated location.

.2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.

.3 Review contents of manual in detail to explain aspects of operation and maintenance.

.4 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.

.5 Time Allocated for Instructions: ensure amount of time required for instruction of each item of equipment or system as follows:

.1 Section 23 73 11 – Air Handling Units – Packaged: 2 hours of instruction.

.2 Section 23 84 13 – Humidifiers: 1 hour of instruction.

.3 Section 25 90 01 – Control System: 2 hours of instruction.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Consultant's approval.

.3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.

.4 Give time and date of each demonstration, with list of persons present.

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

1.3 QUALITY ASSURANCE

.1 When specified in individual Sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:

.1 Instruct Owner's personnel.

.2 Provide written report that demonstration and instructions have been completed.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Acronyms:

.1 Cx - Commissioning.

.2 EMCS - Energy Monitoring and Control Systems.

.3 O M - Operation and Maintenance.

.4 PV - Performance Verification.

.5 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

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

.1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.

.2 Ensure appropriate documentation is compiled into the OM manuals.

.3 Effectively train OM staff.

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

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

.3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

.1 Section 01 91 31 - Commissioning (Cx) Plan.

.2 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) Plan.

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

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

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

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

1.5 PRE-CX REVIEW

.1 Before start of Cx:

- .1 Ensure installation of related components, equipment, sub-systems, systems is complete.
- .2 Fully understand Cx requirements and procedures.
- .3 Understand completely design criteria and intent and special features.
- .4 Have Cx schedules up-to-date.
- .5 Ensure systems have been cleaned thoroughly.
- .6 Complete TAB procedures on systems, submit TAB reports to Consultant for review and approval.
- .7 Ensure "As-Built" system schematics are available.

.2 Inform Consultant in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to Consultant before start-up and obtain clarification.

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

1.7 ACTION AND INFORMATIONAL SUBMITTALS

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

- .1 Submit no later than 4 weeks after award of Contract:
  - .1 Name of Contractor's Cx agent.
  - .2 Draft Cx documentation.
  - .3 Preliminary Cx schedule.
- .2 Request in writing to Consultant for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
- .3 Submit proposed Cx procedures to Consultant where not specified and obtain written approval at least 8 weeks prior to start of Cx.
- .4 Provide additional documentation relating to Cx process required by Consultant.

1.8 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 33 - Performance Verification (PV) Forms for requirements and instructions for use.

1.9 COMMISSIONING SCHEDULE

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

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

1.10 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings.

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

.3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.

.4 At 60% construction completion stage. Consultant to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:

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

.5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

.6 Meeting will be chaired by Cx Agent, who will record and distribute minutes.

.7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

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

1.12 PROCEDURES

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

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

- .1 Included in delivery and installation:

.1 Verification of conformity to specification, approved shop drawings and drawings.

.2 Visual inspection of quality of installation.

.2 Start-up: follow accepted start-up procedures.

.3 Operational testing: document equipment performance.

.4 System PV: include repetition of tests after correcting deficiencies.

.5 Post-substantial performance verification: to include fine-tuning.

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

.4 Document require tests on approved PV forms.

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

.1 Minor equipment/systems: implement corrective measures approved by Consultant.

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Consultant.

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

.1 Rejected equipment to be remove from site and replace with new.

.2 Subject new equipment/systems to specified start-up procedures.

1.13 TEST RESULTS

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

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

1.14 INSTRUMENTS / EQUIPMENT

.1 Submit to Consultant for review and approval:

.1 Complete list of instruments proposed to be used.

.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:

.1 2-way radios.

.2 Ladders.

.3 Equipment as required to complete work.

1.15 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:

.1 Under actual accepted simulated operating conditions, over entire operating range, in all modes.

.2 On independent systems and interacting systems.

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

.3 Follow equipment manufacturer's operating instructions.

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

1.16 WITNESSING COMMISSIONING

.1 Consultant to witness activities and verify results.

1.17 COMMISSIONING CONSTRAINTS

.1 Since access into secure or sensitive areas such as laboratories will be very difficult as building is occupied and functioning, it is necessary to complete Cx during night times unless work is in corridors.

1.18 REPEAT VERIFICATIONS

.1 Assume costs incurred by Consultant for subsequent verifications where:

.1 Verification of reported results fail to receive Consultant's approval.

.2 Repetition of second verification again fails to receive approval.

.3 Consultant deems Contractor's request for second verification was premature.

1.19 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of Consultant.

.2 Report problems, faults or defects affecting Cx to Consultant in writing. Stop Cx until problems are rectified. Proceed with written approval from Consultant.

1.20 COMPLETION OF COMMISSIONING

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

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

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Consultant.

1.21 TRAINING

.1 In accordance with Section 01 79 00 – Demonstration Training.

1.22 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

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

.2 Instrument accuracy tolerances:

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

.3 Measurement tolerances during verification:

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

1.2 GENERAL

.1 Provide a fully functional facility:

.1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies.

.2 Facility user and O M personnel have been fully trained in aspects of installed systems.

.3 Complete documentation relating to installed equipment and systems.

.2 Term "Cx" in this section means "Commissioning".

.3 Acronyms:

.1 Cx - Commissioning.

.2 BMM - Building Management Manual.

.3 EMCS - Energy Monitoring and Control Systems.

.4 MSDS - Material Safety Data Sheets.

.5 PV - Performance Verification.

.6 TAB - Testing, Adjusting and Balancing.

.7 WHMIS - Workplace Hazardous Materials Information System.

1.3 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

.1 Consultant to maintain overall responsibility for project and is sole point of contact between members of commissioning team.

.2 Project Manager will select Cx Team consisting of following members:

.1 Consultant is responsible for:

.1 Monitoring operations Cx activities.

.2 Witnessing, certifying accuracy of reported results.

.3 Witnessing and certifying TAB and other tests.

.4 Ensuring implementation of final Cx Plan.

.5 Performing verification of performance of installed systems and equipment.

.2 Construction Team: DDC controls contractor, air balancing contractor and contractors responsible for construction/installation in accordance with contract documents, including:

.1 TAB.

.2 Performance of Cx activities.

.3 Delivery of training and Cx documentation.

.3 Contractor's Cx agent implements specified Cx activities including:

.1 Demonstrations.

.2 Training.

.3 Testing.

.4 Preparation, submission of test reports.

.4 Owner responsibility for witnessing activities responsible for:

.1 Organizing Cx

1.4 EXTENT OF CX

.1 Commission mechanical systems and associated equipment:

.1 HVAC systems:

.1 AHU-301 – Commissioning in factory

.2 AHU-301 – Commissioning on site.

.2 Noise and vibration control systems for mechanical systems.

.3 Humidifier.

.4 Pumps

.5 EMCS:

1.5 DELIVERABLES RELATING TO THE CX PROCESS

.1 General:

.1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.

.2 Definitions:

.1 Cx as used in this section includes:

.1 Cx of components, equipment, systems, subsystems, and integrated systems.

.2 Performance verification tests.

.3 Deliverables: provide:

.1 Completed performance verification (PV) report forms.

.2 Results of Performance Verification Tests and Inspections.

.3 Consultant to witness and certify tests and reports of results provided to Consultant.

1.6 START-UP

.1 Start up components, equipment and systems.

.2 Consultant to monitor some of these start-up activities.

.1 Rectify start-up deficiencies to satisfaction of Consultant.

.3 Performance Verification (PV):

.1 Approved Cx Agent to perform.

.1 Repeat when necessary until results are acceptable to Consultant.

.2 Use procedures to suit project requirements.

.3 Consultant to witness and certify reported results using approved PV forms.

.4 Consultant will verify up to 30% of reported results at random.

.5 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.7 CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures developed by Consultant and approved by Consultant.

.2 Consultant to monitor Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.4 Consultant to witness, certify reported results of, Cx activities and forward to Owner.

.5 Consultant reserves right to verify a percentage of reported results at no cost to contract.

1.8 CX REPORTS

.1 Submit reports of tests, witnessed and certified by Consultant to Consultant who will verify reported results.

.2 Include completed and certified PV reports in properly formatted Cx Reports.

.3 Before reports are accepted, reported results to be subject to verification by Consultant.

1.9 ACTIVITIES DURING WARRANTY PERIOD

.1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:

.1 Fine tuning of HVAC systems.

.2 Adjustment of ventilation rates to promote good indoor air quality and proper room air pressures.

1.10 TRAINING PLANS

.1 Refer to Section 01 79 00 - Demonstration and Training.

1.11 FINAL SETTINGS

.1 Upon completion of Cx to satisfaction of Consultant lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Commissioning forms to be completed for equipment, system and integrated system.

1.2 PERFORMANCE VERIFICATION (PV) FORMS

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

.2 Prior to PV of integrated system, complete PV forms of related systems and obtain Consultant's approval.

1.3 SAMPLES OF PERFORMANCE VERIFICATION (PV) FORMS

.1 Samples of Performance Verification PV forms will be attached to this section.

1.4 COMMISSIONING FORMS

.1 Use Performance Verification PV forms to verify installation and record performance when starting equipment and systems.

.2 Strategy for Use:

.1 Confirm operation as per design criteria and intent.

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

.3 Verify operation in specified normal and different fume hood air volume settings.

.4 Record analytical and substantiating data.

.5 Verify reported results.

.6 Form to bear signatures of recording technician and reviewed and signed off by Consultant.

.7 Submit immediately after tests are performed.

.8 Reported results in true measured SI unit values.

.9 Provide Consultant with originals of completed forms.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 TYPICAL AIR HANDLER DATA SHEET (AHU-301)

	Specification	Shop Drawing	Installed
Manufacturer:			
Model:			
Serial Number:			
Location:			
Supply Capacity:			
Fan Vibration Isolation:			
Pre-Filter Type:			
Final filter Type:			
Cooling Coil:			
Heating Coil:			

Pre-Filter	Specification	Shop Drawing	Installed
Serial number:			
Manufacturer:			
Model:			
Type:			
QTY & Size of Media:			
Air Flow:			
Efficiency /MERV:			
Seal:			
Housing Size:			
DOP test ports:			

Part 1 TYPICAL AIR HANDLER DATA SHEET (AHU-301)

Final Filter	Specification	Shop Drawing	Installed
Serial number:			
Manufacturer:			
Model:			
Type:			
QTY & Size of Media:			
Air Flow:			
Efficiency /MERV:			
Seal:			
Housing Size:			
DOP test ports:			
HEPA test ports:			

Cooling Coil	Specification	Shop Drawing	Installed
Manufacturer:			
Capacity :			
Air flow:			
EAT (DB):			
LAT (DB):			
Air Side P.D:			
Air Velocity:			
Fluid flow:			
EWT / LWT			
Fluid P.D:			
Rows / Fins			

Part 1 TYPICAL AIR HANDLER DATA SHEET (AHU-301)

Heating Coil	Specification	Shop Drawing	Installed
Manufacturer:			
Capacity :			
Air flow:			
EAT (DB):			
LAT (DB):			
Air Side P.D:			
Air Velocity:			
Fluid flow:			
EWT / LWT			
Fluid P.D:			
Rows / Fins	-		

Supply Fan	Specification	Shop Drawing	Installed
Serial number:			
Manufacturer:			
Model:			
Type:			
Air Volume:			
External Static Pressure:			
Total Static Pressure:			
Voltage:			
Phase:			
RPM:			
BHP:			
Fan Motor Hp:			

Part 1 TYPICAL AIR HANDLER DATA SHEET (AHU-301)

INSTALLATION (Supply Fan)

Fan Housing:		Vibration Isolation:	
Bearing Type:		Flex Connections:	
Alignment/Tension:		Pulley Size/Number:	
Silencer:		Access:	
By-Pass Damper:		Fan Rotation:	
Acoustic Insulation:		Belt Size/Number:	
Thrust Absorbers:		VFD Drive	

PERFORMANCE DATA: *REFER TO BALANCING REPORT (SUPPLY FAN COLD DECK)

Air Volume:	
Fan Static:	
Fan BHP:	
RPM:	

REMARKS/COMMENTS: .....

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.....

.....

CHECKED BY CONTRACTOR: .....

COMPANY ..... DATE: .....

WITNESSED BY AND APPROVED BY CONSULTANT: .....

COMPANY ..... DATE: .....

Part 2 TYPICAL PUMP DATA SHEET (AHU-301, P-311)

	Specification	Shop Drawing	Installed
Serial Number:			
Manufacturer:			
Model:			
Flow:			
Head:			
Seal Type:			
Pump Construction:			
Location:			
Voltage:			
Phase:			
RPM:			
HP:			
Impeller diameter:			

INSTALLATION:

Discharge Valve:		Pump Mounting:	
Suction Valve:		Check Valve:	
Vibration Isolation:		Pressure Gauge:	
Flexible Connection:		Rotation:	
Strainer:		Pump Disconnect Panel:	
Piping Supports:		Unit Identification:	

REMARKS/COMMENTS: .....

.....

CHECKED BY CONTRACTOR: .....

COMPANY ..... DATE: .....

WITNESSED BY AND APPROVED BY CONSULTANT: .....

COMPANY ..... DATE: .....

Part 3 TYPICAL HUMIDIFIER SHEET (H-301)

	Specification	Shop Drawing	Installed
Serial number:			
Manufacturer:			
Model:			
Location:			
Type:			
Steam Capacity:			
Input			
Dispersion Type:			
Dispersion Tube No. & Length.			
Electrical Input			
Electrical FLA			
Electrical V/P/H			

INSTALLATION:

Access:		Blow down:	
Media:		Bleed:	
Trap:		Condenser pan:	
Drip leg:		Isolation valve:	
Strainer:			

REMARKS/COMMENTS: .....

.....

.....

CHECKED BY CONTRACTOR: .....

COMPANY ..... DATE: .....

WITNESSED BY AND APPROVED BY CONSULTANT: .....

COMPANY ..... DATE: .....

PARTS DIAPHRAGM TANK (DT-301)

	Specification	**Shop Drawing**	**Installed**
Manufacturer:			
Model:			
Serial Number:			
Type:			
Location:			
Volume:			
Accept Volume:			
Maximum Operating pressure:			
Operating temp.:			
Dimensions (mm)			

INSTALLATION:

Isolation valves:		Pressure gauges:	
Level gauge:		Drains:	
Air separator:		Pressure relief:	
Air vent:		Unit identification:	

REMARKS/COMMENTS: .....

.....

.....

CHECKED BY CONTRACTOR: .....

COMPANY ..... DATE: .....

WITNESSED BY AND APPROVED BY CONSULTANT: .....

COMPANY ..... DATE: .....

PARTS DIAPHRAGM TANK (DT-301)

TEST 1 General

1.1 SYSTEM TEST PURPOSES

.2 The intent is to test all system components and the EMCS components through a series of checks and procedures designed to exercise the control system as it would be used in normal and abnormal operating procedures.

.3 To ensure system operation as per contract documents

.4 To make adjustments to system components as required to the design intent and operational requirements.

.5 Abbreviations:

.1 “C” denotes contractor sign off.

.2 “E” denotes Engineers verification.

TEST 2 Heating System Test (Typical)

2.1 **TEST PURPOSES**

.1 To test all heating system components and controls

2.2 TEST PRE-REQUISITES

	C	E
.1 All component verifications are complete and approved.	[ ]	[ ]
.2 Vendor start-up and testing has been completed	[ ]	[ ]
.3 Water treatment is complete	[ ]	[ ]
.4 Hydronic balancing is completed.	[ ]	[ ]

2.3 REQUIRED ITEMS

	C	E
.1 Verify water feed system is operational	[ ]	[ ]
.2 Verify that the lead lag sequence for the pump P-311 operates.	[ ]	[ ]
.3 Verify that the heating pump P-311 shut off in summer.	[ ]	[ ]
.4 Verify that the heating loop set point temperature is reset with the outdoor air temperature and that the reset schedule is appropriate.	[ ]	[ ]

TEST 3 Cooling System Test (Typical)

3.1 TEST PURPOSES

.1 To test all cooling system components and controls

3.2 TEST PRE-REQUISITES

		C	E
.1	All component verifications are complete and approved.	[ ]	[ ]
.2	Vendor start-up and testing has been completed	[ ]	[ ]
.3	Water treatment is complete	[ ]	[ ]
.4	Hydronic balancing is completed.	[ ]	[ ]

3.3 REQUIRED ITEMS

		C	E
.1	Verify proper pressure reliefs on systems	[ ]	[ ]
.2	Verify that the cooling loop temperature is controlled at set-point.	[ ]	[ ]

TEST 4 Main Ventilation Unit System Test (Typical)

4.1 TEST PURPOSES

.1 To test the operation of the main ventilation unit.

4.2 TEST PRE-REQUISITES

		C	E
.1	All component verifications are complete and approved.	[ ]	[ ]
.2	Air balance is complete.	[ ]	[ ]
.3	Vendor start-up and testing has been completed.	[ ]	[ ]
.4	Heating System Test is complete.	[ ]	[ ]
.5	Cooling System Test is complete.	[ ]	[ ]
.6	DOP / PAO HEPA filter leakage testing is complete	[ ]	[ ]

4.3 REQUIRED ITEMS

		C	E
.1	Ensure that the outside air dampers close when the unit is shutdown and open fully prior to starting the unit.	[ ]	[ ]
.2	Ensure all motors can be started from the BMS system.	[ ]	[ ]
.3	Verify that supply fans and associated exhaust fan start on minimum volume and ramp up to set point.	[ ]	[ ]
.4	Verify that supply fan speed is controlled to maintain the duct pressure set point.	[ ]	[ ]
.5	Verify that during emergency power failure the supply fans start as per schedule and with specified delay.		
.6	Verify high duct pressure safety alarm	[ ]	[ ]
.7	Verify low air temperature safety alarm.	[ ]	[ ]
.8	Verify unit shuts down on fire alarm.	[ ]	[ ]
.9	Verify unit shuts down on power failure.	[ ]	[ ]

TEST 5 Humidification System Test (Typical)

5.1 TEST PURPOSES

.2 To test the operation of the humidifier.

5.2 TEST PRE-REQUISITES

		C	E
.1	Ventilation system testing is complete	[ ]	[ ]
.2	Vendor start-up and testing has been completed.	[ ]	[ ]

5.3 REQUIRED ITEMS

		C	E
.1	Verify that humidification set point is transferred form the BMS system to the humidification system	[ ]	[ ]
.2	Verify that humidification output is controlled to maintain humidity set point	[ ]	[ ]
.3	Verify that the supply air humidistat ensures that humidifier output does not wet the duct.	[ ]	[ ]
.4	Verify that humidification alarms are passed through to the BMS system.	[ ]	[ ]

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 Demolition: rapid destruction of building following removal of hazardous materials.

.2 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, may include but not limited to: asbestos PCB's, CFC's, HCFC's poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly.

.2 Reference Standards:

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings.

.1 Convene pre-demolition meeting one week prior to beginning work of this Section in accordance with a Construction Progress Schedule to:

.1 Verify project requirements.

.2 Verify specific room and area in which demolition occurs.

.3 Verify nighttime work in rooms.

.4 Review installation conditions.

.5 Coordination with other building subtrades.

.6 Coordinate with building staff requirements.

1.3 QUALITY ASSURANCE

.1 Regulatory Requirements: ensure Work is performed in compliance with applicable Provincial regulations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Storage and Protection.

.1 Protect existing items designated to remain and items designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of Consultant and at no cost to Consultant.

.2 Remove and store materials to be salvaged, in manner to prevent damage.

.3 Store and protect in accordance with requirements for maximum preservation of material.

.4 Handle salvaged materials as new materials.

.2 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials.

1.5 SITE CONDITIONS

.1 Site Environmental Requirements.

.1 Do not dispose of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers.

.1 Ensure proper disposal procedures are maintained throughout the project.

.2 Special Conditions.

.1 Demolition shall not affect operation of AHU-301 and other building equipment.

.2 Other demolition shall occur during a scheduled one week shut down of AHU-301.

Part 2 Products

2.1 EQUIPMENT

.1 Leave HVAC systems and machinery running unless scheduled with owner for night shutdown.

Part 3 Execution

3.1 PREPARATION

.1 Inspect site with Consultant and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

.2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.

3.2 REMOVAL OF HAZARDOUS WASTES

.1 Remove contaminated or dangerous materials defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.

.2 Remove mixing boxes and ductwork containing asbestos or asbestos mastic on ductwork

.3 Legally dispose of removed and hazardous materials.

.4 Include costs for removal of hazardous materials

3.3 REMOVAL OPERATIONS

.1 Remove items as indicated.

.2 Do not disturb items designated to remain in place.

.3 Disposal of Material:

.1 Dispose of materials not designated for salvage or reuse on site at authorized facilities approved in Waste Reduction Work plan as instructed by Consultant.

3.4 RESTORATION

.1 Restore areas and existing works outside areas of demolition to conditions that existed prior to beginning of Work.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day or night shift.

.2 Remove debris, trim surfaces and leave work site clean, upon completion of Work

.3 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.6 PROTECTION

.1 Repair damage to adjacent materials or property caused by selective site demolition.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 Remove and replace metal siding as indicated on drawings to allow removal and replacement of AHU-301

1.2 STORAGE AND HANDLING

.1 Storage and Handling Requirements:

.1 Store materials in dry location indoors off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metal siding from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 FASTENERS

.1 Nails: CSA B111. Screws: ASME B18.6.3. Purpose made cadmium plated steel.

2.2 CAULKING

.1 Sealants:

.1 Test for acceptable VOC emissions in accordance with ASTM D2369 and ASTM D2832.

.2 Adhesives and sealants: VOC limit 250 30 70 g/L maximum to SCAQMD Rule 1168 GS-36.

.3 Polyurethane caulking and color to match existing.

2.3 SHEATHING PAPER

.1 Exterior wall sheathing paper: to CAN/CGSB-51.32, single ply type impregnated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant Departmental Representative DCC Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 INSTALLATION

.1 Install cladding in accordance with CGSB 93.5, and manufacturer's written instructions.

.2 Install one layer exterior wall sheathing paper horizontally by stapling lapping edges150 mm.

.3 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.

.4 Attach components in manner not restricting thermal movement.

.5 Caulk junctions with adjoining work with sealant.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by preformed metal siding installation.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 This work pertains to replacement of demolished drywall (gypsum board) at penthouse wall to allow removal and installation of AHU-301.

1.2 REFERENCE STANDARDS

.1 Aluminum Association (AA)

.1 AA DAF 45-03(R2009), Designation System for Aluminum Finishes.

.2 ASTM International

.1 ASTM C475-02(2007), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

.2 ASTM C514-04(2009e1), Standard Specification for Nails for the Application of Gypsum Board.

.3 ASTM C557-03(2009)e1, Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.

.4 ASTM C840-08, Standard Specification for Application and Finishing of Gypsum Board.

.5 ASTM C954-07, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.

.6 ASTM C1002-07, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.7 ASTM C1047-09, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

.8 ASTM C1280-99, Standard Specification for Application of Gypsum Sheathing.

.9 ASTM C1177/C1177M-08, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

.10 ASTM C1178/C1178M-08, Standard Specification for Glass Mat Water-Resistant Gypsum Backing Board.

.11 ASTM C1396/C1396M-09a, Standard Specification for Gypsum Wallboard.

.3 Association of the Wall and Ceilings Industries International (AWCI)

.1 AWCI Levels of Gypsum Board Finish-97.

.4 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Low-Emitting Materials:

.1 Submit listing of adhesives and sealants paints and coatings used in building, showing compliance with VOC and chemical component limits or restriction requirements.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store gypsum board assemblies materials level in dry location indoors off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.

.3 Protect from weather, elements and damage from construction operations.

.4 Handle gypsum boards to prevent damage to edges, ends or surfaces.

.5 Protect prefinished aluminum surfaces with wrapping strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

.6 Replace defective or damaged materials with new.

1.5 AMBIENT CONDITIONS

.1 Maintain temperature 10 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 Products

2.1 MATERIALS

.1 Standard board: to ASTM C1396/C1396M regular, 16mm thick 1200 mm wide x maximum practical length, ends square cut, edges bevelled.

.2 Exterior gypsum soffit board: to ASTM C1396/C1396M

.3 Nails: to ASTM C514.

.4 Steel drill screws: to ASTM C1002.

.5 Stud adhesive: to ASTM C557 CAN/CGSB-71.25.

.6 Laminating compound: as recommended by manufacturer, asbestos-free.

.7 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

.1 VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.2 Acoustic sealant: in accordance with Section 07 92 00 - Joint Sealants.

.8 Polyethylene: to CAN/CGSB-51.34, Type 2.

.9 Joint compound: to ASTM C475, asbestos-free.

2.2 FINISHES

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

.1 Primer: VOC limit 50 200 100 g/L maximum to SCAQMD Rule 1113 GS-11.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant

3.2 ERECTION

.1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.

.2 Do application of gypsum sheathing to ASTM C1280.

.3 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.

.4 Install work level to tolerance of 1:1200.

3.3 APPLICATION

.1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.

.2 Apply single layer gypsum board to furring or framing using screw fasteners stud adhesive for first layer, . Maximum spacing of screws 300 mm on centre.

.1 Single-Layer Application:

.1 Apply gypsum board on ceilings prior to application of walls to ASTM C840.

.2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.

.3 Install gypsum board with face side out.

.4 Do not install damaged or damp boards.

.5 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

.1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure using contact adhesive for full length at 150 mm on centre.

.2 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:

.1 Levels of finish:

.1 Level 3: embed tape for joints and interior angles in joint compound and apply two separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.

.3 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

.4 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

.5 Apply one coat of white primer sealer over surface. When dry apply finish paint to match existing color.

.6 Mix joint compound slightly thinner than for joint taping.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Material and installation of site applied paint finishes to new interior surfaces, including site painting of shop primed surfaces.

.2 Paint new wall inside mechanical penthouse.

1.2 REFERENCE STANDARDS

.1 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33

.2 Environmental Protection Agency (EPA)

.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Master Painters Institute (MPI)

.1 MPI Architectural Painting Specifications Manual, 2004.

.5 National Research Council Canada (NRC)

.1 National Fire Code of Canada 2015 (NFC).

.6 Society for Protective Coatings (SSPC)

.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

.7 Transport Canada (TC)

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

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.

.2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.

.3 Apprentices: working under direct supervision of qualified trades person in accordance with trade regulations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling and Unloading:

.1 Pack, ship, handle and unload materials in accordance with Section 01 61 00 - Common Product Requirements and manufacturer's written instructions.

.2 Acceptance at Site:

.1 Identify products and materials with labels indicating:

.1 Manufacturer's name and address.

.2 Type of paint or coating.

.3 Compliance with applicable standard.

.4 Colour number in accordance with established colour schedule.

.3 Remove damaged, opened and rejected materials from site.

.4 Storage and Protection:

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

.3 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.

.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

.7 Remove paint materials from storage only in quantities required for same day use.

.8 Fire Safety Requirements:

.1 Provide one dry chemical 9 kg Type ABC fire extinguisher adjacent to storage area.

.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

.3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

1.5 SITE CONDITIONS

.1 Heating, Ventilation and Lighting:

.1 Ventilate enclosed spaces.

.2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.

.3 Provide continuous ventilation for seven days after completion of application of paint.

.4 Coordinate use of existing ventilation system with Consultant and ensure its operation during and after application of paint as required.

.5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.

.6 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Unless pre-approved written approval by Specifying body and product manufacturer, perform no painting when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

.2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.

.4 The relative humidity is under 85 % or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.

.5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.

.2 Perform painting work when maximum moisture content of the substrate is below:

.1 Allow new concrete and masonry to cure minimum of 28 days.

.2 15 % for wood.

.3 12 % for plaster and gypsum board.

.3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".

.4 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Surface and Environmental Conditions:

.1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Additional interior application requirements:

.1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

.2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Consultant such that painted surfaces will have dried and cured sufficiently before occupants are affected.

Part 2 Products

2.1 MATERIALS

.1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.

.2 Provide paint materials for paint systems from single manufacturer.

.3 Only qualified products with E3 "Environmentally Friendly" rating are acceptable for use on this project.

.4 Conform to latest MPI requirements for interior painting work including preparation and priming.

.5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.

.6 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.

.7 Provide paint products meeting MPI "Environmentally Friendly" E3 ratings based on VOC (EPA Method 24) content levels.

.8 Use MPI listed materials having minimum E3 rating where indoor air quality (odour) requirements exist.

.9 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:

- .1 Water-based Water clean-up Water soluble .
- .2 non-flammable biodegradable .
- .3 Manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
- .4 Manufactured without compounds which contribute to smog in the lower atmosphere.
- .5 Do not contain methylene chloride , chlorinated hydrocarbons , toxic metal pigments .

.10 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

.11 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.

.12 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:

- .1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
- .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.

.13 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" E2 rating.

.14 Recycled water-borne surface coatings to contain 50 % post-consumer material by volume.

.15 Recycled water-borne surface coatings must not contain:

.1 Lead in excess of 600.0 ppm weight/weight total solids.

.2 Mercury in excess of 50.0 ppm weight/weight total product.

.3 Cadmium in excess of 1.0 ppm weight/weight total product.

.4 Hexavelant chromium in excess of 3.0 ppm weight/weight total product.

.5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 COLOURS

.1 Submit proposed Colour Schedule to Consultant for review.

.2 Where specific products are available in restricted range of colours, selection based on limited range.

.3 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

.1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Consultant for tinting of painting materials.

.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.

.4 Thin paint for spraying in accordance with paint manufacturer's instructions.

.5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

.1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish (flat)	Max. 5	Max. 10
Gloss Level 2 - Velvet-Like Finish	Max.10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin-Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi-Gloss Finish	35 to 70	

Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

.2 Gloss level ratings of painted surfaces as noted on Finish Schedule as indicated .

2.5 INTERIOR PAINTING SYSTEMS

.1 Asphalt surfaces: zone/traffic marking of interior drive and parking areas:

.1 INT 2.1A - Latex zone/traffic marking finish.

.2 INT 2.1B - Alkyd zone/traffic marking finish.

.2 Concrete vertical surfaces: including horizontal soffits:

.1 INT 3. 1A - Latex insert gloss level finish (over sealer).

.2 INT 3.1B - Latex insert texture type aggregate/latex/ insert gloss level finish.

.3 INT 3.1C - High performance architectural latex insert gloss level finish.

.4 INT 3.1D - Alkyd insert gloss level finish.

.5 INT 3.1E - Latex insert gloss level finish.

.6 INT 3.1F - Epoxy (tile-like) finish for smooth concrete.

.7 INT 3.1G - Waterborne epoxy (tile-like) finish for smooth concrete .

.8 INT 3.1H - Multicolour finish.

.9 INT 3.1J - Water repellent paintable finish.

.10 INT 3.1K - Concrete stain finish.

.11 INT 3.1L - Waterborne light industrial insert gloss level coating.

.12 INT 3.1M - Institutional low odour/low VOC insert gloss level finish.

.13 INT 3.1N - Latex insert gloss level aggregate coating. insert texture type

.3 Concrete horizontal surfaces: floors and stairs:

.1 INT 3.2A - Latex floor enamel gloss low gloss finish.

.2 INT 3.2B - Alkyd floor enamel gloss low gloss finish.

.3 INT 3.2C - Epoxy finish.

.4 INT 3.2D - Pigmented polyurethane finish.

.5 INT 3.2E - Concrete stain finish.

.6 INT 3.2F - Concrete floor sealer.

.7 INT 3.2G - Waterborne concrete floor sealer.

.8 INT 3.2H - Latex zone/traffic marking finish for parking lines, etc. .

.9 INT 3.2J - Alkyd zone/traffic marking finish for parking lines, etc. .

.10 INT 3.2K - Clear (2 component) polyurethane finish.

.11 INT 3.2L - Waterborne epoxy floor finish.

.4 Cementitious composition board surfaces:

.1 INT 3.3A - Latex insert gloss level finish.

.2 INT 3.3B - High performance architectural latex insert gloss level finish.

.3 INT 3.3C - Alkyd insert gloss level finish.

.4 INT 3.3D - Waterborne epoxy (tile like) finish.

.5 INT 3.3E - Epoxy (tile like) finish.

.6 INT 3.3F - Multicolour finish.

.7 INT 3.3G - Institutional low odour/low VOC insert gloss level finish.

.8 INT 3.3H - Waterborne light industrial insert gloss level coating.

.5 Clay masonry units: pressed and extruded brick:

.1 INT 4.1A - Latex insert gloss level finish.

.2 INT 4.1B - Latex insert gloss level aggregate coating. insert texture type

.3 INT 4.1C - Waterborne light industrial insert gloss level coating.

.4 INT 4.1D - Alkyd insert gloss level finish.

.5 INT 4.1F - Epoxy (tile like) finish for smooth brick .

.6 INT 4.1G - Waterborne epoxy (tile-like) finish for smooth brick .

.7 INT 4.1H - Multicolour finish.

.8 INT 4.1J - Clear water repellent paintable finish.

.9 INT 4.1K - Clear (2 component) polyurethane finish.

.10 INT 4.1L - High performance architectural latex insert gloss level finish.

.11 INT 4.1M - Institutional low odour/low VOC insert gloss level finish.

.6 Concrete masonry units: smooth and split face block and brick:

.1 INT 4.2A - Latex insert gloss level finish.

.2 INT 4.2B - Latex insert gloss level aggregate coating. insert texture type

.3 INT 4.2C - Alkyd insert gloss level finish.

.4 INT 4.2D - High performance architectural latex insert gloss level finish.

.5 INT 4.2E - Institutional low odour/low VOC insert gloss level finish.

.6 INT 4.2F - Epoxy (tile-like) finish for dry environments .

.7 INT 4.2G - Epoxy (tile-like) finish for wet environments .

.8 INT 4.2H - Multicolour finish.

.9 INT 4.2J - Waterborne epoxy (tile-like) finish for dry environments .

.10 INT 4.2K - Waterborne light industrial insert gloss level coating.

.11 INT 4.2L - Water repellent non-paintable finish do not use on light weight block .

.12 INT 4.2M - Water repellent paintable finish do not use on light weight block .

.13 INT 4.2N - Alkyd insert gloss level finish (over latex sealer).

.7 Structural steel and metal fabrications: columns, beams, joists:

.1 INT 5.1A - Quick dry enamel gloss semi-gloss finish.

.2 INT 5.1B - Waterborne light industrial insert gloss level coating.

.3 INT 5.1C - Waterborne dry wall finish.

.4 INT 5.1CC - Waterborne dry wall finish (over quick dry shop primer) for dry locations only .

.5 INT 5.1D - Alkyd dry wall finish.

.6 INT 5.1DD - Alkyd dry wall finish (over quick dry shop primer) for dry locations only .

.7 INT 5.1E Alkyd - insert gloss level finish.

.8 INT 5.1F - Pigmented polyurethane finish (over epoxy primer).

.9 INT 5.1G - Pigmented polyurethane finish (over high-build epoxy).

.10 INT 5.1H - Pigmented polyurethane finish (over epoxy and inorganic zinc).

.11 INT 5.1J - Pigmented polyurethane finish (over epoxy and epoxy zinc rich primer).

.12 INT 5.1K - Waterborne epoxy finish.

.13 INT 5.1L - Epoxy finish.

.14 INT 5.1M - Aluminum paint finish.

.15 INT 5.1N - Waterborne light industrial insert gloss level coating (over epoxy primer).

.16 INT 5.1P - High build epoxy (over epoxy zinc rich primer).

.17 INT 5.1Q - Latex insert gloss level finish (over alkyd primer).

.18 INT 5.1R - High performance architectural latex insert gloss level finish.

.19 INT 5.1S - Institutional low odour/low VOC insert gloss level finish.

.20 INT 5.1T - Alkyd insert gloss level finish (over surface tolerant primer).

.21 INT 5.1U - Epoxy finish (over self-priming epoxy).

.22 INT 5.1V - Pigmented polyurethane finish (over self-priming epoxy).

.23 INT 5.1W - Alkyd insert gloss level finish (over quick dry shop primer) for dry locations only.

.24 INT 5.1X - Latex insert gloss level finish (over quick dry shop primer) for dry locations only.

.25 INT 5.1Y - Not Applicable.

.26 INT 5.1Z - Quick dry shop paint finish (for dry locations only) do not topcoat .

.8 Steel - high heat: (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted):

.1 INT 5.2A - Heat resistant enamel finish, maximum 205 degrees C.

.2 INT 5.2B - Heat resist ant aluminum paint finish, maximum 427 degrees C.

.3 INT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.

.4 INT 5.2D - High heat resistant coating, maximum 593 degrees C.

.9 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.

.1 INT 5.3A - Latex insert gloss level finish.

.2 INT 5.3B - Waterborne light industrial insert gloss level coating.

.3 INT 5.3C - Alkyd insert gloss level finish (over cementitious primer).

.4 INT 5.3D - Epoxy finish (over epoxy primer).

.5 INT 5.3E - Epoxy finish (over vinyl wash primer and epoxy primer).

.6 INT 5.3F - Alkyd dry wall finish for use in low contact/low traffic areas only.

.7 INT 5.3G - Aluminum paint finish.

.8 INT 5.3H - Waterborne dry wall finish for use in low contact/low traffic areas only.

.9 INT 5.3J - Latex insert gloss level finish (over waterborne primer).

.10 INT 5.3K - Waterborne light industrial insert gloss level coating (over waterborne primer).

.11 INT 5.3L - Alkyd insert gloss level finish (over non-cementitious primer).

.12 INT 5.3M - High performance architectural latex insert gloss level finish.

.13 INT 5.3N - Institutional low odour/low VOC insert gloss level finish.

.10 Aluminum: unanodized:

.1 INT 5.4A - Alkyd insert gloss level finish.

.2 INT 5.4B - Epoxy finish.

.3 INT 5.4C - Pigmented polyurethane finish.

.4 INT 5.4D - Aluminum paint finish (for exposed aluminum).

.5 INT 5.4E - Waterborne light industrial insert gloss level coating.

.6 INT 5.4F - High performance architectural latex insert gloss level finish.

.7 INT 5.4G - Institutional low odour/low VOC insert gloss level finish.

.8 INT 5.4H - Latex insert gloss level finish.

.9 INT 5.4J - Alkyd insert gloss level finish (over quick dry primer).

.11 Copper:

.1 INT 5.5A - Alkyd insert gloss level for Premium Grade only finish.

.2 INT 5.5B - Epoxy finish.

.3 INT 5.5C - Pigmented polyurethane finish.

.4 INT 5.5D - Aluminum paint finish.

.5 INT 5.5E - Waterborne light industrial insert gloss level coating.

.6 INT 5.5F - High performance architectural latex insert gloss level finish.

.7 INT 5.5G - Institutional low odour/low VOC insert gloss level finish.

.8 INT 5.5H - Latex insert gloss level finish.

.12 Stainless steel: unpolished:

.1 INT 5.6A - Waterborne light industrial insert gloss level coating (over bonding primer).

.2 INT 5.6B - Alkyd insert gloss level finish.

.3 INT 5.6C - Epoxy finish.

.4 INT 5.6D - Pigmented polyurethane finish.

.5 INT 5.6E - Aluminum paint finish.

.6 INT 5.6F - Waterborne light industrial insert gloss level coating (over quick dry primer).

.7 INT 5.6G - High performance architectural latex insert gloss level finish.

.8 INT 5.6H - Latex insert gloss level finish.

.13 Glue laminated beams and columns:

.1 INT 6.1A - Latex insert gloss level finish (over alkyd primer).
.2 INT 6.1B - Alkyd insert gloss level finish.
.3 INT 6.1C - Alkyd varnish insert gloss level finish.
.4 INT 6.1D - Polyurethane varnish insert gloss level finish.
.5 INT 6.1E - Pigmented polyurethane insert gloss level finish.
.6 INT 6.1F - Waterborne clear acrylic insert gloss level finish.
.7 INT 6.1G - Semi transparent stain finish.
.8 INT 6.1H - Alkyd solid colour stain finish.
.9 INT 6.1J - Polyurethane varnish gloss satin finish (over stain).
.10 INT 6.1K - Alkyd varnish insert gloss level finish (over stain).
.11 INT 6.1L - Epoxy finish.
.12 INT 6.1M - Latex insert gloss level finish (over latex primer).
.13 INT 6.1N - High performance architectural latex insert gloss level finish.
.14 INT 6.1P - Alkyd varnish insert gloss level finish (over stain and sealer).
.15 INT 6.1Q - Institutional low odour/low VOC insert gloss level finish.
.16 INT 6.1R - Waterborne clear acrylic insert gloss level finish (over stain).
.17 INT 6.1S - Clear moisture cured polyurethane flat gloss finish (over stain).
.18 INT 6.1T - Latex solid colour stain finish.
.19 INT 6.1U - Pigmented fire retardant coating (ULC rated).
.20 INT 6.1V - Clear fire retardant coating (ULC rated).

.14 Dimension lumber: columns, beams, exposed joists, underside of decking:

.1 INT 6.2A - Latex insert gloss level finish (over alkyd primer).
.2 INT 6.2B - High performance architectural latex insert gloss level finish.
.3 INT 6.2C - Alkyd insert gloss level finish.
.4 INT 6.2D - Latex insert gloss level finish (over latex primer).
.5 INT 6.2E - Multicolour finish.
.6 INT 6.2F - Pigmented fire retardant insert gloss level coating (ULC rated).
.7 INT 6.2G - Clear fire retardant insert gloss level coating (ULC rated).
.8 INT 6.2H - Polyurethane varnish insert gloss level finish.
.9 INT 6.2J - Polyurethane varnish insert gloss level finish (over stain).
.10 INT 6.2K - Alkyd varnish insert gloss level finish (over stain and sealer).
.11 INT 6.2L - Institutional low odour/low VOC insert gloss level finish.
.12 INT 6.2M - Waterborne clear acrylic insert gloss level finish (over stain).
.13 INT 6.2N - Clear moisture cured polyurethane gloss flat finish.
.14 INT 6.2P - Alkyd varnish insert gloss level finish.

.15 Dressed lumber: including doors, door and window frames, casings, mouldings:

.1 INT 6.3A - High performance architectural latex insert gloss level finish.
.2 INT 6.3B - Alkyd insert gloss level finish.

.3 INT 6.3BB - Waterborne alkyd gloss finish interior doors and frames in non-humid locations only.

.4 INT 6.3C - Semi-transparent stain finish do not use on doors.

.5 INT 6.3D - Alkyd varnish insert gloss level finish (over stain).

.6 INT 6.3E - Polyurethane varnish insert gloss level finish (over stain).

.7 INT 6.3F - Lacquer insert gloss level finish (over stain).

.8 INT 6.3G - Pigmented lacquer insert gloss level finish.

.9 INT 6.3H - Clear lacquer insert gloss level finish.

.10 INT 6.3J - Alkyd varnish insert gloss level finish.

.11 INT 6.3K - Polyurethane varnish insert gloss level finish.

.12 INT 6.3L - Epoxy finish.

.13 INT 6.3M - Danish oil finish.

.14 INT 6.3N - Multicolour finish.

.15 INT 6.3P - Waterborne light industrial insert gloss level coating.

.16 INT 6.3Q - Waterborne clear acrylic insert gloss level finish.

.17 INT 6.3R - Pigmented fire retardant insert gloss level finish (ULC rated).

.18 INT 6.3S - Clear fire retardant finish (ULC rated).

.19 INT 6.3T - Latex gloss semi-gloss finish (over latex primer).

.20 INT 6.3U - Latex semi-gloss finish (over alkyd primer).

.21 INT 6.3V - Institutional low odour/low VOC insert gloss level finish.

.22 INT 6.3W - Waterborne clear acrylic insert gloss level finish (over stain).

.23 INT 6.3X - Clear moisture cured polyurethane gloss flat finish.

.24 INT 6.3Y - Clear moisture cured polyurethane flat gloss finish (over stain).

.25 INT 6.3Z - Clear (2 component) polyurethane finish.

.16 Wood paneling and casework: partitions, panels, shelving, millwork:

.1 INT 6.4A - Latex insert gloss level finish (over alkyd sealer).

.2 INT 6.4B - Alkyd insert gloss level finish (over alkyd sealer).

.3 INT 6.4C - Semi-Transparent stain finish.

.4 INT 6.4D - Alkyd varnish insert gloss level finish (over stain).

.5 INT 6.4E - Polyurethane varnish insert gloss level finish (over stain).

.6 INT 6.4F - Lacquer insert gloss level finish (over stain).

.7 INT 6.4G - Alkyd varnish insert gloss level finish.

.8 INT 6.4H - Pigmented lacquer insert gloss level finish.

.9 INT 6.4J - Polyurethane varnish insert gloss level finish.

.10 INT 6.4K - Danish oil finish.

.11 INT 6.4L - Multicolour finish.

.12 INT 6.4M - Waterborne clear acrylic insert gloss level finish.

.13 INT 6.4N - Waterborne light industrial insert gloss level coating.

.14 INT 6.4P - Pigmented fire retardant insert gloss level coating (ULC rated).

.15 INT 6.4Q - Clear fire retardant coating (ULC rated).

.16 INT 6.4R - Latex semi-gloss finish (over latex primer).
.17 INT 6.4S - High performance architectural latex insert gloss level finish.
.18 INT - 6.4T Institutional low odour/low VOC insert gloss level finish.
.19 INT 6.4U - Waterborne clear acrylic insert gloss level finish (over stain).
.20 INT 6.4V - Clear moisture cured polyurethane gloss flat finish (over stain).
.21 INT 6.4W - Lacquer insert gloss level finish (over wood stain).
.22 INT 6.4X - Pigmented lacquer insert gloss level finish.
.23 INT 6.4Y - Clear lacquer insert gloss level finish.

.17 Wood floors and stairs: including hardwood flooring:

.1 INT 6.5A - Alkyd floor enamel low gloss finish.
.2 INT 6.5B - Polyurethane varnish gloss finish (over stain).
.3 INT 6.5C - Polyurethane varnish gloss finish.
.4 INT 6.5D - Not applicable.
.5 INT 6.5E - Alkyd game line marking.
.6 INT 6.5F - Epoxy game line marking.
.7 INT 6.5G - Latex porch and floor gloss low gloss enamel finish.
.8 INT 6.5H - Waterborne epoxy floor finish.
.9 INT 6.5J - Moisture cured polyurethane flat gloss finish (over stain).
.10 INT 6.5K - Moisture cured polyurethane gloss finish.

.18 Wood shingle and shake siding:

.1 INT 6.6A - Latex insert gloss level finish.
.2 INT 6.6B - Alkyd insert gloss level finish.
.3 INT 6.6C - Semi-transparent stain finish.
.4 INT 6.6D - Alkyd solid colour stain finish.
.5 INT 6.6E - Latex solid colour stain finish.
.6 INT 6.6F - Latex insert gloss level finish (over latex primer).
.7 INT 6.6G - Pigmented fire retardant insert gloss level coating (ULC rated).
.8 INT 6.6H - Clear fire retardant insert gloss level coating (ULC rated).

.19 Fibreglass: panels, trims, fabrications:

.1 INT 6.7A - Latex insert gloss level finish.
.2 INT 6.7B - Alkyd insert gloss level finish.
.3 INT 6.7C - Waterborne light industrial insert gloss level coating.
.4 INT 6.7D - Epoxy finish.
.5 INT 6.7E - Pigmented polyurethane finish.
.6 INT 6.7F - Waterborne epoxy insert gloss level finish.
.7 INT 6.7G - Multicolour finish.
.8 INT 6.7H - High performance acrylic latex insert gloss level finish.
.9 INT 6.7J - Institutional low odour/low VOC insert gloss level finish.

.20 Plastic: lumber, panels, trims, fabrications, vinyl wall covering, PVA/PVC materials:

.1 INT 6.8A - High performance architectural latex insert gloss level finish.

.2 INT 6.8B - Alkyd insert gloss level finish.

.3 INT 6.8C - Waterborne light industrial insert gloss level coating.

.4 INT 6.8D - Multicolour finish.

.5 INT 6.8E - Latex insert gloss level finish.

.6 INT 6.8F - Institutional low odour/low VOC insert gloss level finish.

.21 Spray textured surfaces: ceilings:

.1 INT 9.1A - Latex flat finish spray application only.

.2 INT 9.1B - Latex insert gloss level finish (over alkyd sealer).

.3 INT 9.1C - Alkyd flat finish.

.4 INT 9.1D - Alkyd insert gloss level finish (over alkyd sealer).

.5 INT 9.1E - Latex finish spray application only.

.22 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:

.1 INT 9.2A - Latex insert gloss level finish (over latex sealer).

.2 INT 9.2B - High performance architectural latex insert gloss level finish.

.3 INT 9.2C - Alkyd insert gloss level finish (over latex sealer).

.4 INT 9.2E - Epoxy (tile-like) finish.

.5 INT 9.2F - Waterborne epoxy (tile-like) finish.

.6 INT 9.2G - Multicolour finish.

.7 INT 9.2H - Clear Pigmented fire retardant coating (ULC rated).

.8 INT 9.2J - Waterborne fire retardant coating (ULC rated).

.9 INT 9.2K - Latex insert gloss level finish (over alkyd primer) for plaster surfaces only.

.10 INT 9.2L - Waterborne light industrial insert gloss level coating.

.11 INT 9.2M - Institutional low odour/low VOC insert gloss level finish.

.23 Acoustic panels and tiles:

.1 INT 9.3A - Latex flat finish.

.2 INT 9.3B - Latex insert gloss level finish (over alkyd sealer).

.3 INT 9.3C - Alkyd flat finish.

.4 INT 9.3D - Institutional low odour/low VOC insert gloss level finish.

.5 INT 9.3E High performance architectural latex insert gloss level finish.

.24 Canvas and cotton coverings.

.1 INT 10.1A - Latex insert gloss level finish.

.2 INT 10.1B - Alkyd insert gloss level finish.

.3 INT 10.1C - Aluminum paint finish.

.4 INT 10.1D - Institutional low odour/low VOC insert gloss level finish.

.25 Bituminous coated surfaces: cast iron pipe, concrete, etc.:

.1 INT 10.2A - Latex insert gloss level finish.

.2 INT 10.2B - Alkyd insert gloss level finish.

.3 INT 10.2C - Aluminum paint finish.

2.6 SOURCE QUALITY CONTROL

.1 Perform following tests on each batch of consolidated post-consumer material before surface coating is reformulated and canned. Testing by laboratory or facility which has been accredited by Standards Council of Canada.

.1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.

.2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.

.3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

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 data sheet.

3.2 GENERAL

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Consultant damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.

.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.3 Maximum moisture content as follows:

.1 Stucco, plaster and gypsum board: 12 %.

.2 Concrete: 12 %.

.3 Clay and Concrete Block/Brick: 12 %.

.4 Wood: 15 %.

3.4 PREPARATION

.1 Protection:

.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Consultant.

.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

.3 Protect factory finished products and equipment.

.4 Protect building occupants and general public in and about the building.

.2 Surface Preparation:

.1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.

.2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative Consultant DCC Representative .

.3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.

.2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

.4 Allow surfaces to drain completely and allow to dry thoroughly.

.5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.

.6 Use trigger operated spray nozzles for water hoses.

.7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.

.4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.

.2 Apply wood filler to nail holes and cracks.

.3 Tint filler to match stains for stained woodwork.

.6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

.7 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by blowing with clean dry compressed air brushing with clean brushes vacuum cleaning.

.8 Touch up of shop primers with primer as specified.

.9 Do not apply paint until prepared surfaces have been accepted by Consultant

3.5 APPLICATION

.1 Method of application to be as approved by Consultant. Apply paint by brush or roller. Conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:

.1 Apply paint in uniform layer using brush and/or roller type suitable for application.

.2 Work paint into cracks, crevices and corners.

.3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.

.4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.

.5 Remove runs, sags and brush marks from finished work and repaint.

.3 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.

.4 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.6 Sand and dust between coats to remove visible defects.

.7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

.8 Finish inside of cupboards and cabinets as specified for outside surfaces.

.9 Finish closets and alcoves as specified for adjoining rooms.

.10 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 NEW MECHANICAL/ELECTRICAL EQUIPMENT

.1 Paint finished area exposed conduits, piping, hangers, ductwork and other new mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.

.2 Boiler room, mechanical and electrical rooms: paint exposed new conduits, piping, hangers, ductwork and other mechanical and electrical equipment.

.3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.

.4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

.5 Do not paint over nameplates.

.6 Keep sprinkler heads free of paint.

.7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matte black paint.

.8 Paint fire protection piping red.

.9 Paint disconnect switches for fire alarm system and exit light systems in red enamel.

.10 Paint natural gas piping yellow.

.11 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

.12 Do not paint interior transformers and substation equipment.

3.7 SITE TOLERANCES

.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.

.2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.

.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 FIELD QUALITY CONTROL

.1 Field inspection of painting operations to be carried out by independent inspection firm as designated by Consultant Departmental Representative DCC Representative .

.2 Advise Consultant when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.3 Cooperate with inspection firm and provide access to areas of work.

3.9 RESTORATION

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.

.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.

.2 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data 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 current model production.

.5 Certification of compliance to applicable codes.

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

1.2 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data.

.1 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.3 Maintenance data to 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.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.

.2 Make changes as required and re-submit as directed by Consultant.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 Consultant will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.8 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, 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 Consultant for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

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

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

.2 Furnish spare parts 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 filter cartridge or set of filter media for each filter or filter bank in addition to final operating set. This includes HEPA filters.

.3 Provide one set of special tools required to service equipment as recommended by manufacturers.

.4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect from nicks, scratches, and blemishes

.3 Replace defective or damaged materials with new.

Part 2 Execution

2.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

2.2 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 23 - Interior Painting.

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

.3 Restore to new condition, finishes which have been damaged.

2.3 SYSTEM CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling unit.

2.4 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL 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.

2.5 DEMONSTRATION

.1 Consultant will 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 AHU-301

.2 Humidifier H301

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

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

.5 Instruction duration time requirements as specified in appropriate sections.

2.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

2.7 PROTECTION

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

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.2 Canadian Standards Association (CSA International)

.1 CSA B139-04, Installation Code for Oil Burning Equipment.

.3 National Research Council Canada (NRC)

.1 National Fire Code of Canada 2015 (NFC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

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

Part 2 Products

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.2 Sealants:

.1 Sealants: maximum VOC limitto GSES GS-36.

.3 Sealants: maximum VOC limit to GSES GS-36 to SCAQMD Rule 1168.

.4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and as indicated without interrupting operation of other system, equipment, components.

3.4 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

.1 Install air vents to in piping systems at high points.

.2 Install isolating valve at each air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

.1 Install pipework to CSA B139.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

- .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible and as indicated.

.12 Ream pipes, remove scale and other foreign material before assembly.

.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.14 Provide for thermal expansion as indicated.

.15 Valves:

- .1 Install in accessible locations.
- .2 Remove interior parts before soldering.
- .3 Install with stems above horizontal position unless indicated.
- .4 Valves accessible for maintenance without removing adjacent piping.
- .5 Install globe valves in bypass around control valves.
- .6 Use gate valves at branch take-offs for isolating purposes except where specified.

.16 Check Valves:

- .1 Install silent check valves on discharge of pumps and as indicated.
- .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere:

.1 Provide space for firestopping.

.2 Maintain fire rating integrity.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: one piece type with set screws.

.1 Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush systems.

.2 Before start-up, clean interior of piping systems as specified in relevant mechanical sections.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise consultant 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Consultant.

.6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Consultant .

3.12 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Consultant .

.2 Request written approval by Consultant 10 days minimum, prior to commencement of work.

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

3.13 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 GENERAL

.1 ASTM International

.1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.2 Factory Mutual (FM)

.3 Underwriter's Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of B.C., Canada.

.2 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.1 Consultant will make available 1 copy of systems supplier's installation instructions.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

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

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.

.2 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.3 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into connected equipment.

.4 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

2.3 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.4 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.5 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

.1 Provide templates to ensure accurate location of anchor bolts.

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 in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.3 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.4 Use approved constant support type hangers where:

.1 Transfer of load to adjacent hangers or connected equipment is not permitted.

.5 Use variable support spring hangers where:

.1 Transfer of load to adjacent connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

.3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.4 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

.1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

3.5 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL 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.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

.3 National Building Code of Canada (NBC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.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 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 Province of BC, Canada.

.2 Provide separate shop drawings for each isolated system, system shop drawings complete with performance and product data.

.3 Provide detailed drawings of seismic control measures for equipment.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Consultant will make available 1 copy of systems supplier's installation instructions.

.3 Manufacturer's Field Reports: manufacturer's field reports specified.

.4 Submit BC Building Code Letters of Assurance Schedule B and C signed by a professional engineer to consultant.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 GENERAL

.1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

.2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30durometer natural rubber; maximum loading 415 kPa.

.3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

.4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

.1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.3 Colour code springs.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

.6 Performance: as indicated.

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

.6 Performance: as indicated.

2.7 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.8 SEISMIC CONTROL MEASURES

.1 General:

.1 Seismic control systems to work in every direction.

.2 Fasteners and attachment points to resist same maximum load as seismic restraint.

.3 Drilled or power driven anchors and fasteners not permitted.

.4 No equipment, equipment supports or mounts to fail before failure of structure.

.5 Seismic control measures not to interfere with integrity of fire-stopping.

.6 Seismic slack cables as required for equipment such as dual duct mixing boxes and VAV boxes.

.2 Static equipment:

.1 Anchor equipment to equipment supports. Anchor equipment supports to structure.

.2 Suspended equipment:

.1 Use one or more of following methods depending upon site conditions as indicated:

.1 Install tight to structure.

.2 Cross brace in every direction.

.3 Brace back to structure.

.4 Cable restraint system.

.3 Seismic restraints:

.1 Cushioning action gentle and steady.

.2 Never reach metal-like stiffness.

.3 Vibration isolated equipment:

.1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.

.2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.

.3 As indicated.

.4 Bracing methods:

.1 Approved by Consultant.

.2 Structural angles or channels.

.3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

.5 Seismic Restraint Standard of Acceptance:

Vibra-Sonic Control or acceptable alternatives in construction or performance approved by Engineer.

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 Seismic control measures to meet requirements of NBC.

.2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.3 Ensure ducting connections to isolated equipment do not reduce system flexibility and that ducting passage through walls and floors do not transmit vibrations.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

.2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

.1 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Consultant within 3 days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.2 Provide Consultant with notice 24 h in advance of commencement of tests.

.3 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and requirements for the identification of duct work and controllers including the installation and location of identification systems.

.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 Canadian Gas Association (CGA)

.1 CSA/CGA B149.1-[05], Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-[97], Interior Alkyd Gloss Enamel.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

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

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

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

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.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, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.

.2 Equipment in Mechanical Rooms: use size # 9.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Before starting work, obtain written approval of identification system from Consultant.

2.4 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.5 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.6 LANGUAGE

.1 Identification in English.

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 TIMING

.1 Provide identification only after painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC CSA registration plates as required by respective agency.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON DUCTWORK SYSTEMS

.1 On long straight runs in open areas at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change 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 separations such as walls, floors, partitions.

.6 Where system is installed in chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

.2 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.3 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.4 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.5 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.6 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

.3 Refer to specification sections 01 11 00 and 01 14 00 for work restrictions

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Consultant for verification of TAB reports.

1.9 START OF TAB

.1 Notify Consultant 7 days prior to start of TAB.

.2 Start TAB when construction is essentially completed, including:

.3 Installation of other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23 and Division 25.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 5 %, minus 5 %.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2 % of actual values.

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Consultant list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 6 copies of TAB Report to Consultant for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Consultant.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Number and location of verified results as directed by Consultant.

.4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Consultant.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section and TAB standards of AABC NEBB SMACNA ASHRAE.

.2 Do TAB of systems, equipment, components and controls specified Division 23 and Division 25 for the following systems, equipment, components and controls:

.1 Adjust AHU-301 supply air quantities to achieve required room pressures and room airflows.

.3 Qualifications: personnel performing TAB current member in good standing of AABC qualified to standards of AABC.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

1.20 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.2 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

.2 TAB procedures:

.1 Generally, the building is to be air balanced to the following conditions and as shown on the drawings:

.1 Lab 222 – positive pressure

.3 Zone pressure differences:

.1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.

.2 TAB procedures:

.1 AHU-301 shall be balanced so that fan VSD speed correlates with duct pressure sensor setting and VAV box settings.

.2 Note that current approximate running conditions of AHU-301 will be 1600 l/s at 250 Pa E.S.P.

1.21 POST-OCCUPANCY TAB

.1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.

.2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547-2003, Mineral Fiber Pipe Insulation.

.7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

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

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.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.

.3 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 BC, Canada.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00 - 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 label beneath sample indicating service.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, member qualified to standards of TIAC.

.3 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

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

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility approved by Consultant .

.4 Dispose of unused adhesive material at official hazardous material collections site approved by Consultant .

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 ASTM C547.

.2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 ASTM C547.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702 ASTM C547.

.5 TIAC Code C-2: mineral fibre blanket faced with without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702 ASTM C547.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C547 CAN/ULC-S702.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Air drying Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

- .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
- .2 Colours: to match adjacent finish paint Consultant.
- .3 Minimum service temperatures: -20 degrees C.
- .4 Maximum service temperature: 65 degrees C.
- .5 Moisture vapour transmission: 0.02 perm.
- .6 Fastenings:
  - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
  - .2 Tacks.
  - .3 Pressure sensitive vinyl tape of matching colour.

.2 ABS Plastic:

- .1 One-piece moulded type and sheet with pre-formed shapes as required.
- .2 Colours: to match adjacent finish paint Consultant.
- .3 Minimum service temperatures: -40 degrees C.
- .4 Maximum service temperature: 82 degrees C.
- .5 Moisture vapour transmission: 0.012 perm.
- .6 Thickness: 0.75 mm.
- .7 Fastenings:
  - .1 Solvent weld adhesive compatible with insulation to seal laps and joints.
  - .2 Tacks.
  - .3 Pressure sensitive vinyl tape of matching colour.

.3 Canvas:

- .1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.

.4 Aluminum:

- .1 To ASTM B209.
- .2 Thickness: 0.50 mm sheet.
- .3 Finish: smooth corrugated stucco embossed.
- .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

.5 Stainless steel:

- .1 Type: 316 304.

.2 Thickness: 0.25 mm.

.3 Finish: corrugated stucco embossed smooth.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

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 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, flanges and unions at equipment primary flow measuring elements.

.2 Design: to permit movement of expansion joint to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: Tape SS bands wire at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: Tape SS bands wire at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-2.

.1 Insulation securements: _____

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-H.

.5 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 over			
Steam	up to 175	A-1	38	50	65	75	90	90
Steam, Saturated and Super heated	over 175	A-1	38	65	65	75	90	90
Condensate Return	60 - 94	A-1	25	38	38	38	38	38
Pumped Condensate return	up to 94	A-1	25	38	38	38	38	38
Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38
Glycol Heating	60 - 94	A-1	25	38	38	38	38	38

Glycol Heating	up to 59	A-1	25	25	25	25	38	38
Domestic HWS	A-1	25	25	25	38	38	38	
Chilled Water	4 - 13	A-3	25	25	25	25	25	25
Chilled Water or Glycol	below 4	A-3	25	25	38	38	38	38
Domestic CWS	A-3	25	25	25	25	25	25	
Domestic CWS with vapour retarder	C-2	25	25	25	25	25	25	
Cooling Coil cond. drain	C-2	25	25	25	25	25	25	

.6 Finishes:

.1 Exposed indoors: PVC.

.2 Exposed in mechanical rooms: PVC.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Finish attachments: SS bands, at 150 mm on centre. Seals: closed wing.

.6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.8 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Pump operation.

.2 Three way valve bypass open/closed.

.3 Control pressure failure.

.4 Maximum heating demand.

.5 Maximum cooling demand.

1.3 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.7 Chilled water system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Adding heat from building heating system or;

.2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above.

1.4 REPORTS

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports.

1.5 TRAINING

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified herein.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Instructions: submit manufacturer's installation instructions.

.1 Consultant will make available 1 copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

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 CLEANING HYDRONIC AND STEAM SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 hours at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.7 Repeat with water at design temperature.

.8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.9 Bring system up to design temperature and pressure slowly.

.10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancingfor HVAC.

.11 Adjust pipe supports, hangers, springs as necessary.

.12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.13 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.14 Check operation of drain valves.

.15 Adjust valve stem packings as systems settle down.

.16 Fully open balancing valves (except those that are factory-set).

.17 Check operation of over-temperature protection devices on circulating pumps.

.18 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

1.2 REFERENCE STANDARDS

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings except Low-Rise Residential Buildings.

.2 CSA Group

.1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.

.3 Electrical Equipment Manufacturers Association of Canada (EEMAC)

.4 National Electrical Manufacturers' Association (NEMA)

.1 NEMA MG 1-2011, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

.3 Shop Drawings:

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

.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.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.

1.5 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.

.3 Storage and Handling Requirements:

.1 Store materials in dry location indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic pumps from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 EQUIPMENT

.1 Size and select components to: CAN/CSA-B214.

2.2 IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.

.2 Impeller: cast iron.

.3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135 degrees C.

.5 Coupling: flexible self-aligning.

.6 Motor: TEFC, to NEMA MG 1 drip proof, sleeve bearing,

.7 Capacity: as indicated on drawings.

.8 Pump P-301A shall be Grunfos, Model BMQE-15 with accessories 91121987, 96437852, 91121984.

.9 Pump P-311 shall be Grunfos, Model MAGNA-3-D-80-100F dual head.

.10 Standard of Acceptance: Grunfos, Armstrong, Bell and Gosett.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied

3.2 APPLICATION

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

3.3 INSTALLATION

.1 Install hydronic pumps to: CAN/CSA-B214.

.2 In line circulators: install as indicated by flow arrows.

- .1 Support at inlet and outlet flanges or unions.
- .2 Install with bearing lubrication points accessible.

.3 Ensure that pump body does not support piping or equipment.

- .1 Provide stanchions or hangers for this purpose.
- .2 Refer to manufacturer's installation instructions for details.

.4 Pipe drain tapping to floor drain.

.5 Install volute venting pet cock in accessible location.

.6 Check rotation prior to start-up.

.7 Install pressure gauge test cocks.

3.4 START-UP

.1 General:

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.
- .2 In accordance with manufacturer's recommendations.

.2 Procedures:

- .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
- .2 After starting pump, check for proper, safe operation.
- .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
- .4 Check base for free-floating, no obstructions under base.
- .5 Run-in pumps for 12 continuous hours minimum.
- .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
- .7 Eliminate air from scroll casing.
- .8 Adjust water flow rate through water-cooled bearings.
- .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
- .10 Adjust alignment of piping and conduit to ensure true flexibility.
- .11 Eliminate cavitation, flashing and air entrainment.
- .12 Adjust pump shaft seals, stuffing boxes, glands.
- .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
- .14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

3.5 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 01 91 13 - General Commissioning(Cx) Requirements: General Requirements, supplemented asspecified herein.

.2 Verify that manufacturer's performance curves are accurate.

.3 Ensure valves on pump suction and discharge provide tight shut-off.

.4 Net Positive Suction Head (NPSH):

.1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

.2 Measure using procedures prescribed in Section 01 91 13 - General Commissioning(Cx) Requirements.

.3 Where procedures do not exist, discontinue PV, report to Consultant DCC Representative Departmental Representative and await instructions.

.5 Multiple Pump Installations - Series and Parallel:

.1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.

.6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

.7 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning(Cx) Requirements reports supplemented as specified herein.Reports to include:

.1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.

.2 Use Report Forms specified in Section 01 91 13 - General Commissioning(Cx) Requirements: Report Forms and Schematics.

.3 Pump performance curves (family of curves).

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

.1 ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings: Class 25, 125, 250 and 800.

.2 ASME B16.25-07, Buttwelding Ends.

.3 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.

.4 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings: NPS ½ through 24.

.5 ANSI/ASME B16.9-07, Factory-Made Wrought Steel Buttwelding Fittings.

.6 ANSI B18.2.1-96(R2005), Square and Hex Bolts and Screws (Inch Series).

.7 ANSI/ASME B18.2.2-87(R2005), Square and Hex Nuts (Inch Series).

.2 American National Standards Institute (ANSI) / American Water Works Association (AWWA)

.1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.3 ASTM International Inc.

.1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM A126-04, Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.

.4 Canadian Standards Association (CSA International)

.1 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.

.5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

.1 MSS-SP-70-2006, Cast Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS-SP-71-2005, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS-SP-80-2003, Bronze Gate, Globe, Angle and Check Valves.

.4 MSS-SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for valves and pipes and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in BC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section01 61 00 - Common Product Requirements.

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

Part 2 Products

2.1 PIPE

.1 Stainless Steel pipe: to ASTM A53/A53M, Grade B, as follows:

.1 Steam;

.1 To NPS 6

.2 NPS 8 and over

.2 Condensate

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings with lead-free dope .

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.

.3 Flanges: plain or raised face. Flange gaskets to ANSI/AWWA C111/A21.11.

.4 Pipe thread: taper.

.5 Bolts and nuts: stainless steel, to ANSI/ASME B18.2.1 ANSI/ASME B18.2.2.

2.3 FITTINGS

.1 Pipe flanges: stainless steel to ASME B16.1, Class 125.

.2 Screwed fittings: stainless steel to ASME B16.3, Class 150.

.3 Stainless Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.

.4 Buttwelding fittings: steel to ANSI/ASME B16.9.

.5 Unions: stainless steel, to ASTM A47.

2.4 VALVES

.1 Connections:

.1 NPS 2 and smaller: screwed ends.

.2 NPS 2 1/2 and larger:

.1 Equipment: Flanged ends.

.2 Elsewhere: Flanged ends.

.2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines.

.1 NPS 2 and under:

.1 Mechanical Rooms: Class 125, rising stem, splitwedge disc

Part 3 Execution

3.1 APPLICATION

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

3.2 PIPING

.1 Install pipework in accordance with Section 23 05 05 - Installation of Pipework.

.2 Connect branch lines into top of mains.

.3 Install piping in direction of flow with slopes as follows, unless indicated:

.1 Steam: 1:240.

.2 Condensate return: 1:70.

.4 Make provision for thermal expansion.

.5 Drip pocket: line size.

3.3 VALVES

.1 Install globe valves around, NPS 8 and over, gate valves.

3.4 TESTING

.1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.

.2 Test pressure: 1-1/2 times maximum system operating pressure or 860 kPa whichever is greater.

3.5 SYSTEM START-UP

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.6 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems supplemented as specified herein.

.2 Timing, only after:

.1 Pressure tests successfully completed.

.2 Flushing as specified has been completed.

.3 Water treatment system has been commissioned.

.3 PV Procedures:

.1 Verify complete drainage of condensate from steam coils.

.2 Verify proper operation of system components, including, but not limited to:

.1 Steam traps - verify no blow-by.

.2 Thermostatic vents.

.3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.

.4 Humidifiers: for commissioning procedures, refer to Section 23 84 13 - Humidifiers.

.5 Condensate pumping units: for commissioning procedures, refer to Section 01 91 13 - General Commissioning (Cx) Requirements.

3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation of high-pressure metallic ductwork, joints and accessories at supply and fresh air connections to AHU-301.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials (ASTM).

.1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. (Metric).

.3 Department of Justice Canada (Jus).

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

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

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.5 Sheet Metal Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 95 (Addendum No. 1, (1997).

.2 SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition1985.

.3 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.

1.3 QUALITY ASSURANCE

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Protect on site stored or installed absorptive material from moisture damage.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Place materials defined as hazardous or toxic in designated containers.

.5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

.6 Ensure emptied containers are sealed and stored safely.

.7 Fold up metal, plastic banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 DUCTWORK

.1 Material:

.1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.

.2 Thickness: to SMACNA.

.2 Construction - round and oval.

.1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.

.2 Transverse joints up to 900mm: slip type with tape and sealants.

.3 Transverse joints over 900mm: Vanstone.

.4 Fittings:

.1 Elbows: smooth radius. Centreline radius: 1.5 x diameter.

.2 Branches: conical transition with conical branch at 45 degrees and 45 degrees elbow.

.3 Construction - rectangular:

.1 Ducts: to SMACNA.

.2 Fittings:

.1 Elbows: smooth radius; centreline radius 1.5 x width of duct. No vanes.

.2 Branches: with conical branch at 45 degrees and 45 degrees elbow.

.4 Firestopping:

.1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.

.2 Firestopping material must not distort duct.

2.2 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
2500	A
1500	A
1000	A
750	B

.2 Seal classification:

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

.2 Class B: longitudinal seams, transverse joints and connections made airtight with gaskets, sealant, tape, or combination thereof.

2.3 SEALANT

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

2.4 TAPE

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

2.5 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for Equipment.

.1 Band hangers: use on round and oval ducts up to 500 mm diameter, of same material as duct.

.2 Trapeze hangers: ducts over 500 mm diameter or longest side, to ASHRAE or SMACNA.

.3 Hangers: galvanized steel angle with black steel rods to following table.

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp or steel plate washer.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 GENERAL

.1 Do work in accordance with ASHRAE, SMACNA as indicated.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate band hangers 100 mm beyond insulated duct.

.2 Ensure diffuser is fully seated.

.3 Support risers in accordance with ASHRAE, SMACNA as indicated.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Ensure installation of firestopping does not distort duct.

.6 Connect existing duct work to AHU-301 with new ductwork.

3.2 HANGERS

.1 Band hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: as follows:

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500

3.3 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA and manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.4 LEAKAGE TESTS

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Perform leakage tests in sections.

.4 Perform trial leakage tests, as instructed to demonstrate workmanship.

.5 Do not install additional ductwork until trial tests have been achieved.

.6 Complete tests before performing insulation or concealment Work.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)

.1 ANSI/AHRI 430-10, Performance Rating of Central Station Air-Handling Units.

.2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)

.1 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

.2 ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings except Low-Rise Residential Buildings.

.3 Master Painters Institute (MPI)

.1 Architectural Painting Specification Manual - current edition.

.1 MPI #18.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for insulation, filters, humidifier spray, VSD, adhesives, and paints and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC.

.2 Indicate on drawings: fan, bearings, motor drive, VAV, fan curves showing point of operation, filters coil; include performance data.

1.3 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for air handling equipment for incorporation into manual.

.3 Include following: air volume, OAT, sensible cooling, motor, fan, damper, total cooling, bearings, VAV control, EDB, EWB, spray section.

.4 Product data shall include dimensions, weights, capacities, certifications, component performance, electrical characteristics, casing construction details, wiring interconnections, gauges and finishes of materials.

.5 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of this specification. It is the

responsibility of the supplier to highlight any variances that his equipment has with the requirements of this specification whether or not pre-approval has been obtained. Provide the information in the same measurement units as indicated elsewhere in this specification.

.6 Provide fan curves (not fan tables), with specified operating points clearly plotted.

.7 Provide coil selection worksheets, clearly showing proper consideration for altitude, air density, and water corrections. Indicate coil tube fin and casing construction.

.8 Provide filter information, including initial APD, final APD, dust spot efficiency, final dust holding capacity, filter media description, filter frame details, and filter removal details.

.9 Submit sound power levels for both air handling unit inlet, outlet and radiated at rated capacity. If unit exceeds sound power levels at scheduled conditions, manufacturer must provide sound attenuators and meet specified BHP.

.10 Submit electrical requirements for power supply and control wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

.11 Submit manufacturer’s recommended installation instructions.

.12 Omission of any of the above information will cause shop drawings to be immediately returned without review

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

.2 Provide 1 spare sets of filters including HEPA filters.

.3 Provide 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.

.4 Spare filters: in addition to filters installed immediately prior to acceptance by Consultant, supply 1 complete set of filters for each filter unit or filter bank including dynamic V8 filters and HEPA filters.

.5 Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect air handling equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Deliver products to site on a factory-installed base rail or shipping skid. Ship units over the road with 10 mil poly shrink-wrap.

1.6 Quality Assurance

.1 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock.

.2 Air handling units and major components shall be products of the manufacturer regularly engaged in production of such equipment.

.3 Fans shall conform to AMCA bulletins regarding testing and construction. Airfoil fans shall bear the AMCA certified rating seal for airflow and sound.

.4 Coils shall be ARI certified.

.5 Filter media shall be ULC listed.

.6 Units with factory wiring shall be factory UL/ETL/CSA approved and labeled. Failure to comply with this requirement shall necessitate the manufacturer at his expense to have a certified UL/ETL/CSA representative inspect the equipment prior to affixing a label.

.7 Air handling units and major components shall be products of manufacturing firms regularly engaged in manufacture of this equipment with characteristics and capacities required and whose products have been in satisfactory use in similar service for not less than 10 years.

1.7 Approved Equals

.1 Contractors price shall be based on Haakon Industries. Prices for alternate air handlers may be shown as an optional line item, separate from the base price, and will be evaluated after the tender close only. For consideration of proposed alternate air handlers after the tender close, the contractor shall provide for review and acceptance:

.1 Complete shop drawing submittal, including performance, wiring drawings, dimensional data

.2 Control submittal, including control interface points, control wiring drawings, and sequence of operation.

.3 Details on local service capability of supplier, including number of technicians on staff, proximity to jobsite, and years of experience of each technician.

.4 Marked copy of this specification, with exceptions clearly highlighted and guarantee of compliance to this specification where exceptions are not noted.

.5 Written guarantee to cover any additional site installation costs associated with the supply of the proposed alternate air handler. The air handler shown on the drawings has been coordinated with architectural and structural elements, and with electrical service requirements. If a different unit is submitted, ALL mechanical, electrical, architectural and structural modifications which are required shall be performed under the work of the mechanical section, by the mechanical contractor, under the original contract price.

.2 Standard of Acceptance: Haakon, Scott Springfield, EngAir.

Part 2 Products

2.1 GENERAL

.1 Factory assembled components to form unit supplying air at designed conditions, as indicated.

.2 Certify ratings: to ANSI/AHRI 430 with AHRI seal.

.3 Horizontal one piece type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, humidifier spray section heating coil, dampers, filter section, HEPA filter section, cooling coil, VFD, integral controls.

.4 Provide factory assembled air handling unit in configuration as indicated on drawings. Unit shall include all specified components installed at the factory. Field fabrication of units and their components will not be accepted.

.5 All units shall be inspected, tested and commissioned by the customer at local factory prior to shipment. Inspection, testing and commissioning shall be of unit completely assembled.

.6 Provide DOP/PAO HEPA filter leakage testing in factory prior to shipment. Testing is to be done by Con-Test. Provide similar testing after unit is installed.

.7 The unit shall be designed to be supported by a house keeping pad.

.8 Units too large to be legally shipped on the road may be shipped to site in sections. Otherwise units shall be shipped in one piece

2.2 CASINGS

.1 Galvanized steel 1.6 mm (16 gauge) thickness reinforced and braced forrigidity.

.1 Walk-in access doors: provide access for maintenance of internal parts.

.2 Paint steel parts, where not galvanized, with corrosion resistant paint to MPI #18.

.1 Paint: maximum VOC limit 250 g/L to SCAQMD Rule 1113 to GS-11.

.3 Finish units, inside and out, with rust resistant enamel.

.1 Enamel Finish: maximum VOC limit 250 g/L to SCAQMD Rule 1113 to Standard GS-11.

.2 Line casing with solid steel liner.

.3 Walls and roofs shall be constructed of 16 gauge galvanized steel 2” thick acoustic thermal panels. (The inner liner shall be 22 gauge solid wash-down galvanized steel. Insulation shall be 2” thick 3 lbs density fiberglass. Provide neoprene liner to seal insulation. Insulation shall meet flame spread rating of less than 25 and a smoke developed rating of less than 50 when measured in accordance with ASTM E84. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8” x 3/8” tape sealer. Tape sealer shall be LEED qualified. Wall seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight tight.

.4 Internal liner shall be suitable for washing with a pressure washer or steam cleaned without risk of wetting the insulation. The liner shall be installed over top of the panel flanges and each liner seam shall be sealed with a lap joint. The wall liner shall be

installed over top of the base water dam such that any water run-off from the liner will drip into the water tight base rather into the wall panel. The roof liner shall be installed over top of the roof support so that water cannot enter the roof insulation.

.5 All insulation edges shall be joined on 8" centers using zinc plated TEK screws or metal clinches.

.6 All insulation edges shall be protected with metal lagging. Insulation systems using stickpins or adhesives are not acceptable.

.7 Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, add additional internal reinforcing.

.8 Acoustical Performance:

.1 The housing shall have been tested for acoustical performance by an independent laboratory that is accredited.

.2 Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.

.3 Sound Transmission Loss DB ASTM E-90 & E413-73

	1	2	3	4	5	6	7	8	
2" Walls	18	19	27	33	43	52	52	52	STC=37
4" Walls	20	20	28	41	51	56	55	57	STC=40

.4 Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83.

.5 Sound Absorption ASTM C423-84A & E795-83

	1	2	3	4	5	6	7	8	
2" Walls	.10	.23	.75	1.08	1.05	.99	.97	.95	STC=37
4" Walls	.40	.65	1.38	1.28	1.09	1.05	1.02	1.02	STC=40

.6 Submit lab report for approval.

2.3 BASE CONSTRUCTION

.1 Units shall be constructed from structural steel C-channel iron around the perimeter of the unit, with intermediate channel and angle iron supports. Units less than or equal to 20' long shall have a minimum 4" channel, and units greater than 20' shall have a minimum 6" channel.

.2 A 0.12" thick aluminum checker plate floor shall be installed on the base. Floor shall be flat reinforced from below, with all seams continuously welded. Drive screw attachment and caulking are not acceptable. Base shall be provided with lifting lugs, minimum four (4) per unit section. The base shall be insulated with 3" fiberglass insulation and sheeted with a 22 gauge galvanized steel liner. Floors that "oil can" are not acceptable.

.3 Provide a 1.5" perimeter collar around the entire unit, and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5" of water.

.4 Provide auxiliary 1.25" drains in fan sections downstream of cooling coils, and in humidifier sections.

.5 All drain connections on floor mounted air handling units shall terminate at the side of the unit.

.6 Maximum base deflection shall be ¼" on 240" unsupported span.

2.4 ACCESS DOORS

.1 Access doors shall be manufactured from 16 gauge galvanized steel. The doors shall be double wall construction with 22 gauge solid metal liner on the inside. Corners of the doors shall be continuously welded for rigidity. Two inch 3 lb/cu ft. density insulation shall be sandwiched between the 16 gauge outer layer and the 22 gauge inner layer. Doors must be the same thickness as the unit casing to maximize thermal and acoustical resistance.

.2 Two polish finished copper-nickel plated high pressure cam-style latches operable from either side of the door shall be provided. Door opening shall be fully gasketed with continuous ½" closed cell hollow round black gasket with a metal encapsulated reinforcing backing that mechanically fastens to the door frame. Door frames shall be made from 16 gauge galvanized steel with the outside size of the door flush with the unit. Fan compartments must have a door of minimum width to remove the motor.

.3 All access doors must swing against the air pressure (i.e. positive pressure plenum doors must swing in). Provide safety latches for doors opening with air pressure.

2.5 DRAIN PANS

.1 Construction: stainless steel, rounded corners.

.2 Insulation: external foam type, minimum 13 mm thick.

.3 Drain connection: in bottom at low point.

.4 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.

.5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

2.6 FANS

.1 Free standing AMCA-rated for sound and performance centrifugal (plenum plug) fan with airfoil wheels, selected to operate in stable part of performance curve at times and heavy duty 200,000 hours service self-aligning split pillow block bearings.

.1 Provide internally mounted motor as indicated complete with adjustable V-belt drive and guard.

.2 Motor: to ANSI/ASHRAE/IES 90.1.

.2 Maximum sound power levels, as indicated.

.3 Internally mounted motor and fan.

.4 Fans shall be manufactured by Haakon, Twin City, Barry Blower or Mechanovent. Fans shall be centrifugal plenum (plug) type, designed without a scroll type housing. Fans shall incorporate a wheel, heavy gauge reinforced steel inlet plate with removable spun inlet cone, structural steel frame, and shaft and bearings in AMCA Arrangement 3 configuration as an entire assembly.

.5 All fan wheels shall have tapered spun wheel cones or shrouds providing stable flow and high rigidity. The wheels shall be non-overloading type.

.6 The blades shall be continuously-welded, die-formed Airfoil type, designed for maximum efficiency and quiet operation. Partial welding will not be acceptable on airfoil blades.

.7 Impellers shall be statically and dynamically balanced and complete fan assembly shall be test balanced at the operating speed prior to shipment.

.8 Shafts to be sized for first critical speed of at least 1.43 times the maximum speed for the class. Bearings are to be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for an L10 200,000 hour life at the maximum class RPM.

.9 Provide OSHA approved fully enclosed metal belt guard sides of galvanized steel and expanded metal face. Belt guard shall be sized to allow either sheave to be increased by two sizes.

.10 Plenum fan assembly must have an enclosed safety screen as per OSHA Standards.

.11 Fans shall have inlet OSHA approved inlet screens.

2.7 VIBRATION ISOLATION

.1 Flexible connections at inlet and outlet of fan.

.2 Vibration isolators on fan section complete with seismic restraints as indicated: in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

2.8 VARIABLE VOLUME DEVICES

.1 Variable speed drive on supply fan.

2.9 FILTER BOX

.1 Material to match casing. For HEPA and dynamic V8 type filter arrangement: as indicated.

.1 Provide access to filters through hinged door with suitable hardware.

.2 Provide blank-off plates and gaskets to prevent air bypass.

.3 Filters: in accordance with drawing schedules.

.1 Minimum Efficiency Reporting Value (MERV) value 13 filtration media to ANSI/ASHRAE 52.2, to be used on fresh air section of air handling unit.

2.10 COILS

.1 Capacity: as indicated.

.2 Ratings: ARI certified.

.3 Construction:

.1 Casings: 1.5 mm thick galvanized sheet steel.

.1 Supports of galvanized steel channel .

.2 Blank-off plates. Insulated sandwich construction.

.3 Face and bypass dampers

.4 General

.1 All coils shall meet or exceed all capacities specified on the mechanical schedule for the project. All coil performance shall be certified by the manufacturer in accordance with ARI Standard 410.

.2 Construct coils of configuration plate fins and seamless tubes. Aluminum fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

.3 Construct coil casings of minimum 16 gauge steel with formed end supports and top and bottom channels. Coils in cooling service shall have stainless steel casings and coils in heating-only service shall have galvanized steel casings.

.4 Coils shall be fully enclosed within casing and cooling coils shall be on mounted 304 stainless steel angle racks manufactured to allow coils to slide out individually. Heating coils shall be mounted on galvanized angle racks manufactured to allow coils to slide out individually.

.5 Removable coil access panels shall be provided to remove coils through casing wall. Coils shall be individually removable towards (away from) the access side. Coils must be individually racked, removable through the side access panels.

.6 Drain pans shall be continuously welded 304 stainless steel. Coil section must have intermediate drain pans and shall be interconnected with 1” drain lines. Drain pans shall be IAQ sloped and fully drainable.

.7 Pipe connections shall be on the same end, extended through the casing for ease of connection, employing a plate over the connection to minimize leakage, and shall be threaded.

.8 On staggered coils, pipe connections shall be extended to the exterior of the unit using schedule 40 pipe. The pipe shall be supported with structural stands and the pipe clamped to the stands with 1” thick thermally broken pipe clamps. For cooling coils, the support structure for the pipe extensions shall be made from stainless steel. Insulation of pipe extensions shall be provided by installer on site after installation.

.9 Water coils shall be drainable.

.10 Water cooling or Heating Coils

.1 Clearly label supply and return headers on outside of units such that direction of coil water-flow is counter to direction of unit air-flow.

.2 Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.

.3 Construct headers of round copper pipe.

.4 Construct tubes of 5/8 inch O.D. minimum .024 inch thick copper and construct fins of 0.0075 thick aluminum.

2.11 HUMIDIFIERS

.1 In accordance with Section 23 84 13 - Humidifiers.

2.12 AIRFLOW MEASURING PROBES

.1 Provide on each fan air flow measuring probes capable of continuously monitoring the air handling capacity of the respective (plenum) fan.

.2 Each airflow probe shall contain multiple, averaged velocity pressure taps located symmetrically around the throat of the fan inlet and a single static pressure tap located on the fan housing. The entire airflow monitoring probe must be located outside the inlet throat as to not obstruct airflow.

.3 The probes shall be capable of producing steady, non-pulsating signal of the velocity pressure, independent of the upstream static pressure without adversely affecting the performance of the fan. The sensing probes shall be accurate ±3% of actual fan airflow. The fan inlet sensing rings shall be **FreeFlo Sensing Ring** as manufactured by Haakon Industries Ltd.

2.13 AIRFLOW DISPLAY

.1 Provide on indicated fans a method of displaying digitally, in real time, the fans current air flow.

.2 For interaction with a controller, the display shall output one (1) 0-10VDC signal for each fan being monitored.

.3 The output signal shall be accurate to ±0.5% of Natural Span, including non-linearity, hysteresis and non-repeatability.

.4 The display must be water tight allowing for use in outdoor locations. If the display is not water tight it shall be enclosed in a weatherproof housing.

2.14 VIBRATION ISOLATION

.1 An integral all welded epoxy coated steel vibration isolation base shall be provided for the fan and motor.

.2 Isolators shall be free standing with sound deadening pads and leveling bolts.

.3 Spring diameter to compressed operating height ratio shall be 1 to 1.

.4 Spring deflection shall be a minimum of 2”.

.5 Isolators shall have seismic restraints designed to meet IBC 2006 requirements. Manufacturer shall provide seismic calculations upon request.

2.15 MOTORS

.1 Motors shall be severe duty motors to IEEE 841 standards and labeled as IEEE841.

.2 Motor enclosure shall be totally enclosed fan cooled and rated to IP55. A non metallic cooling fan shall be provided. Frame, end bells and fan cowl shall be manufactured of

heavy duty cast iron. The end plates shall be sealed to the frame joints. Enclosure shall be epoxy coated and rated for ASTM B117-90 96 hour salt spray test.

.3 Conduit box shall be manufactured from cast iron and shall be provided with threaded inlet, neoprene gasket for lid and have a lead separator gasket. The conduit box shall be convertible from F1 to F2 position.

.4 Motor windings shall be Design B and have class F insulation with class B temperature rise. Windings shall be 200C inverter spike resistant wire. Motor windings shall withstand 2000V transients. Motor service factor shall be 1.15 on sine wave power and 1.0 on VFD power.

.5 Both bearings shall have Inpro seals. Bearings shall be regreasable without disassembly and provide for the elimination of purged grease. Bearing life shall be a minimum of L10 of 50000 hours.

.6 Motors shall be balanced to less than 0.08 inches per second (filter out). Vibration test data shall ship with motor. Foot flatness shall be within 0.005".

.7 Nameplates shall be stainless steel and contain NEMA data and bearing data.

.8 Motors shall be premium efficiency and compatible with VFDs in accordance with NEMA MG1 part 31.

.9 Motors for use with VFDs shall be provided with a motor shaft grounding system.

.10 Motor shall be provided with a 3 year warranty.

.11 Acceptable motor manufacturers are Reliance-Baldor, US Motors, and TECO-Westinghouse.

2.16 DYNAMIC V8 FILTERS

.1 GENERAL: The initial system filtration shall be comprised a bank of electronically active field polarized media air cleaners.

.2 Certifications: The air cleaner shall have been tested and meet CSA Standard C22.2 No. 187-M19986 and UL Standard 867 for electrostatic air cleaners.

.3 Operation: The air cleaner shall have an active electrostatic field that polarizes a dielectric media. It shall not ionize airborne particles or produce ozone.

.4 V8 Filter Performance: When using the ASHRAE 52.2 protocol with no carbon in the loading dust, the air cleaner shall test at MERV 15. It will have a clean static pressure drop of .42" w.g. and shall increase in resistance no more than .25" w.g. with a dust loading of 2,855 grams. It shall hold a total of 4,582 grams of dust at its final resistance of 1.4" w.g. per 24x24 module. The single pass removal efficiency shall have the following single pass minimum removal efficiencies by particle size.

0.3 microns — 91%
0.5 microns — 94.4 %
0.7 microns — 96.6 %
< 1.0 microns — 98.1 %
>1.0 microns — 99.1 %

.5 V8 Filter Construction: The Air Cleaner modules shall consist of eight individual air cleaners. The construction of the air cleaner frame shall be aluminum and screens and

side panels shall be galvanized steel. The Air Cleaner modules and each component thereof must have a positive seal where necessary to prevent bypass of air.

.6 Electronics: The high voltage Powerheads shall require 24 volts AC input. The Powerheads must be fully potted and connected in parallel.

.7 Power Supply: The 24VAC power supply must be a UL or CSA certified transformer, class "2" type, which shall permit one side of the secondary output (24V) to be attached to electrical ground.

.8 Filter Media: Each Air Cleaner shall have a disposable and recyclable media pad with a minimum of a class "2" fire rating. It shall have a positive seal in the frame.

.9 Configuration: The air cleaners will be arranged in a pre-fabricated module assembly comprised of eight separate air cleaners and galvanized metal sides and attachment flanges.

.10 Filter Monitoring System: Air cleaners shall be equipped with a power monitoring system that alarms in the event of a loss of electrical continuity between filter panels. Control Panel shall have Magnahelic gauge and pressure switch.

.11 Filter Rack: The frames and electronics of the V-Banks will be permanently mounted in the air handler. The filter rack will be constructed so as to allow front access for media changes of V-Bank assembly.

2.17 LIGHTS

.1 Marine lights with protective metal cage and glass seals complete with duplex receptacles shall be installed on the wall across from the access doors. A switch with an indicator light shall be installed on the unit. Electrical power shall be 120V/1/60. Lights shall be equipped with compact fluorescent bulbs. Wiring for lighting shall be in rigid EMT conduit with rain tight fittings. A separate green bonding wire shall be provided. Each lighting circuit shall be 15A

2.18 BELLMOUTH DISCHARGES AND INLETS

.1 Where shown on the plans or where a discharge is 1500 fpm or more, discharges shall have a radiused curve equal to the thickness of the casing.

2.19 FINISH

.1 Unit shall be finished painted with two components, etch bond primer and finish painted with alkyd enamel, as selected by Owner. All uncoated steel shall be painted with grey enamel. All metal surfaces shall be prepainted with vinyl wash primer to ensure paint bonds to metal. Outdoor unit shall be finish coated with polyurethane paint. Paint for outdoor units shall be tested to ATSM B117 for 5000hr salt spray endurance.

2.20 ALUMINUM AIRFOIL DAMPERS (FACE AND BYPASS)

.1 Aluminum airfoil frames and blades shall be a minimum of 12 gauge extruded aluminum. Blades shall be of a single unit airfoil design 6" wide.

.2 Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames: 2" x 4" x 5/8" on linkage side, 1" x 4" x 1" on the other 3 sides.

.3 Pivot rods shall be 7/8" hexagon extruded aluminum interlocking into blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.

.4 Bearing shall be designed so that there is not metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.

.5 Blade linkage hardware shall be installed in frame out of air-stream. All hardware shall be on non-corrosive, reinforced material of cadmium plated steel.

.6 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

.7 Jack shaft assemblies shall be provided for multiple damper installations.

.8 Standard of Acceptance: Tamco 1500, Ruskin, Ventex.

2.21 DAMPER OPERATORS

.1 Provide factory installed fully modulating electric damper operators with all linkage and hardware internally mounted.

.2 Ensure operators are mounted in easily accessible sections of the air handling unit.

.3 Standard of Acceptance: Belimo

2.22 AIR FLOW TESTING

.1 Unit manufacturer shall factory test each unit to ensure that it meets the specified air flow of 2880 l/s and operating airflow of 1600 l/s.

.2 The test shall be carried out in accordance with the guidelines set forth in AMCA 210 "Laboratory Methods for Testing Fans for Rating". The unit shall be fitted with a long run of straight ductwork with a flow straightener to allow fully developed flow. The airflow shall be measured using a pitot tube traverse or a calibrated flow measuring station in the duct at the location prescribed by the AMCA guidelines. The performance shall be corrected for temperature, pressure and elevation.

.3 An officer of the air handling unit company shall certify test results. Forward copies of certified test results to the consultant (the consultant shall witness the air flow test on the first two units). Provide for all transportation for the consultant and owner to the factory.

2.23 AIR LEAKAGE TESTING

.1 Unit manufacturer shall factory pressure test each air handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at 1.5 times the rated static pressure. (Leakage test shall be performed with all VFD and humidifier panels installed, all electrical gear installed, and all coil penetrations made). Provide DOP/PAO HEPA filter leakage testing by CON-TEST

.2 Test shall be conducted in accordance with SMACNA duct construction manual. All external openings shall be blocked off with temporary plates. The unit shall be pressurized to the test pressure using an external blower. A calibrated orifice shall be used to measure leakage airflow into or out of the unit.

.3 An officer of the air handling unit company shall certify test results. Forward copies of certified test results to the consultant. (The consultant shall witness the pressure test and

air leakage test. Provide for all transportation costs for the consultant, and owner to the factory).

.4 Positive pressure plenums shall be tested positively and negative pressure plenums shall be tested negatively.

.5 The above tests shall be repeated at the site after the air handling unit is installed and operational.

2.24 FLOOD TESTING

.1 All unit bases shall be flooded with water to a level of 1.5" after manufacturing to assure no leakage through the floor and perimeter water barrier. The results of the flood test shall be certified by the manufacturer.

2.25 VIBRATION TESTING AND BALANCING

.1 Fans and motors shall be dynamically balanced to exceed a BV-5 criterion as per AMCA 204-96. The test shall be conducted after the fan and motor base assembly has been completed. The entire fan assembly including fan wheels, shafts, bearings, drives, belts, motors, isolation bases shall be tested. During the test, the fan and motor base shall be supported by its isolators which are set in the freely floating operating position. (In cases where a concrete inertia base is provided, the factory poured concrete shall be installed at the time of the vibration test).

.2 The required measurement points are as follows: one horizontal measurement and one vertical measurement shall be taken for each fan and motor bearing and one axial measurement shall be taken for each shaft. (A total of 10 points for a typical belt driven fan-motor assembly). The measurements shall be taken using calibrated, magnetically mounted accelerometers and a calibrated measuring instrument.

.3 Vibration measurement locations shall be as close as possible to the bearing or shaft centerlines. Measurements shall be taken from the bearing housings, bearing pedestals, or motor casings. Measurements shall not be taken from flexible covers or shields.

.4 Fans and motors shall be tested at the design RPM and the maximum overall filter-in vibration levels at each measurement point shall be less than or equal to 0.15 in/second peak velocity at the operating speed. If any measurements exceed the above criterion, the assembly shall be rebalanced and re-tested until the criterion is achieved.

.5 Certified measurements shall be provided to the consultant

2.26 ELECTRICAL

.1 Factory wire and test all air handling units. Have units approved by CSA, ETL or UL.

.2 Supply one (1) single point 600 V/60 Hz/3 Ph power connection for the unit. Wire all 120 V/60 Hz/1 Ph components for lights from a panel with circuit breakers for each type of electric device. Panel for 120 V/208 V/60 Hz/3 Ph is fed from a separate service.

.3 Label and number code all wiring and electrical devices in accordance with the unit electrical diagram. Mount the devices in a control panel inside the unit's service enclosure or on the outside. Ensure the control panel meets the CSA, ETL or UL.

.4 Provide a system of motor control including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, auxiliary contactors and terminals

for the connection of external control devices or relays. Individually fuse all fan and branch circuits. On fans designated to be operated by Variable Frequency Drives, provide VFDs rather than contactors.

.5 Wire from the motors to the motor control in accordance with CSA, ETL or UL and contained by EMT conduit with liquid tight connections. Seal the casing penetrations in a manner that eliminates air leaks.

.6 Provide a through the door type disconnect at the main power connection point.

2.27 FACTORY MOUNTED CONTROLS

.1 The manufacturer shall furnish all material required for direct digital control of components specified. All components shall be installed in EMT conduit with liquid tight fittings. Electrical interlock wiring of field devices [e.g. flow switches, thermostats] is the responsibility of the contractor.

.2 An integral control panel shall be provided complete with hinged access door and locking device. All contents shall be labeled and wired to a numbered terminal strip. Wiring shall be colour-coded and number-tagged at each end to match diagram supplied. Control panels shall include control transformer, control circuit fuses, DDC unit controller and all controls required for automatic operation.

.3 DDC unit controller is microprocessor based capable of BACnet interface to BAS. All setpoints, programmable bands, control algorithms and any other programmable parameters are stored such that a power failure of any duration will not necessitate reprogramming. Controller has built in status and adjustment panel to allow for local adjustment of all setpoints, temporary override of output points and display of all input values, output values and alarm conditions.

.4 The manufacturer shall supply and install 1000 ohm platinum temperature sensors. The sensors shall be located where they will register accurate measurement of the monitored value. The mixed air sensor shall be of the averaging type. The return air and outdoor air shall be single point duct mount type. Temperature transmitter shall be located at the sensor and output [0-10 vdc] shall terminate on a numbered terminal strip in the main electrical panel. The manufacturer shall provide temperature sensors in the following locations:

.1 Outdoor air

.2 Heating coil discharge

.3 Cooling coil discharge

.4 Discharge air

.5 The manufacturer shall supply and install safety controls. Safety control transmitters shall be located at the sensor and output [0-10 vdc] shall terminate on a numbered terminal strip in the main electrical panel. The manufacturer shall provide the following safety controls:

.1 Freeze protection thermostat -- one freeze stat for each 20 square feet of coil surface to be protected.

.2 Differential pressure switch -- one differential pressure switch for each bank of filters including HEPA and V8 filters and one differential pressure switch for each fan.

.3 Differential pressure control -- a manual reset differential pressure control in the fan discharge plenum and one in the mixing plenum for over pressure protection.

.6 The manufacturer shall supply and install the humidity sensors. The humidity sensors shall be accurate 1% Humidity transmitters shall be located at the sensor and outputs [0-10 vdc] shall terminate on a numbered terminal strip in the main electrical panel. The manufacturer shall provide humidity sensors in the following locations:

.1 Outdoor air

.2 Discharge air

.7 The manufacturer shall supply and install damper actuators for all dampers supplied with air handling unit. Actuator outputs [0-10 vdc] shall terminate on a numbered terminal strip in the main electrical panel.

.8 Microprocessor controller to be factory programmed per the operating sequence described in specification section 25 90 01.

.9 Unit controls shall be compatible with the existing Reliable building DDC system through BACnet.

.10 Refer to Section 25 90 01 for Sequences of Operation and other requirements.

2.28 TEST PORTS

.1 Provide 1” diameter test ports for unit air stream testing in each plenum section between each component within the AHU. Also provide HEPA filter bank testing ports on each side of the filter. Test ports shall have a tube that extends between the inside and outside of the unit and a screwed cap on the exterior to allow access. The test ports shall have been flanged on the exterior to allow air seal and shall be flanged on the interior to cover the penetration of the casing.

2.29 STEAM HUMIDIFIERS

.1 Air handling unit manufacturer shall mount steam grid provided by humidifier manufacturer. Balance of steam humidifier components shall be mounted in the field by the contractor. Provide minimum absorption distance downstream of humidifier as scheduled.

.2 Furnish and install where indicated on the drawings ULTRA-SORB packaged steam injection type humidifier panel(s) as manufactured by DRI-STEEM.

.3 Each ULTRA-SORB panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Each tube shall be fitted with two rows of steam discharge tubelets inserted into the tube wall centered on the diametric line and spaced 1 ½” inches apart. These tubelets shall be made of a non-metallic material designed for steam temperatures. The two rows shall discharge steam in diametrically opposite directions. Each tubelet shall contain a steam orifice sized for its required steam capacity.

.4 Each packaged humidifier panel assembly of tubes and headers shall be contained with a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple ULTRA-SORB panels in ducts or air handler casing.

.5 All tubes and headers shall be of 304 stainless steel and joints shall be heli-arc welded. Tubes shall be jointed to headers with slip fit couplers.

.6 The ULTRA-SORB humidifier shall be furnished with appropriate steam valve, steam strainer and steam traps (when used), all shipped loose for installation on the job.

.7 Standard of Acceptance: Dri-Steem, Nortec, Armstrong.

2.30 DRAINS

.1 Provide 1.25" capped floor drain connections on the side of the unit for complete drain ability of the base pan for the following sections:

.1 Humidifier Sections

.2 Fan Sections

.3 Section upstream and downstream of coils

2.31 FAN VARIABLE FREQUENCY DRIVE

.1 General

.1 Description

.1 This specification covers complete a variable frequency drive (VFD) for the supply fan. All standard and optional features shall be included within the VFD panel.

.2 The VFD shall be UL Type 1 or UL Type 12 as required on the schedule. The VFD shall have been evaluated by UL and found acceptable for mounting in a plenum or other air handling compartment. Manufacturer shall supply a copy of the UL plenum evaluation upon request.

.3 The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. When the VFDs are to be located in Canada, C-UL certifications shall apply. VFD shall be manufactured in ISO 9001, 2000 certified facilities.

.4 The VFD manufacturer shall supply the VFD and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

.2 Products

.1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor de-rating.

.2 When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

.3 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

.4 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

.5 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

.6 The VFD's full load output current rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

.7 The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed de-rating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

.8 A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

.9 The VFD must be able to produce full torque at low speed to operate direct drive fans.

.10 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

.11 An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

.12 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

.13 All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

.3 Protective Features

.1 A minimum of Class 20 I^2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

.3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or

issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

.4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

.5 Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.

.6 The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

.7 VFD shall include a “signal loss detection” algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

.8 VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.

.9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

.10 Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

.11 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

.12 If the temperature of the VFD’s heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD’s temperature becomes too high.

.13 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

.14 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

.15 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

.4 Interface Features

.1 Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

.2 There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.

.3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

.4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

.5 All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

.7 Display shall be programmable to communicate in multiple languages including English, Spanish and French.

.8 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

.9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

.10 Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.

.11 Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

.12 A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

.13 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).

.14 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or

over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

.15 Standard Control and Monitoring Inputs and Outputs

.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

.2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

.1 Each relay shall have an adjustable on delay / off delay time.

.4 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

.1 Each shall be independently selectable to be used with either an analog voltage or current signal.

.2 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

.3 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

.4 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

.5 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

.6 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.

.7 It shall be possible to command all digital and analog output through the serial communication bus.

.16 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

.17 A real-time clock shall be an integral part of the VFD.

.5 Serial Communications

.1 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

.1 BACnet MS/TP

.2 Modbus RTU

.6 Adjustments

.1 The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

.2 Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

.3 Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

.4 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

.5 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

.6 An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

.7 Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

.8 When incorporated in the air handler’s design, provide a manual 2-contactor bypass consisting of a door interlocked main disconnect pad lockable in the off position, a built-in motor starter and a three position DRIVE/OFF/BYPASS switch controlling two contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. The VFD can be remotely controlled in this position with a pilot relay and analog signal or can be controlled manually using the hand function on the VFD LCD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed form the AC power line. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.

.7 Service Conditions

.1 Ambient temperature, continuous, full speed, full load operation:

.1 UL Type 1 & 12 (NEMA 1 & 12): -10 to 40°C (14 to 104°F) through 350 HP @ 460 and 600 volt, through 60 HP @ 208 volt. De-rating to 50°C is possible for NEMA 1 units – consult the manufacturer for guidelines.

.2 IP20: -10 to 50°C (14 to 122°F) through 125 HP @ 460 and 600 volt, through 60 HP @ 208 volt

.2 0 to 95% relative humidity, non-condensing.

.3 AC line voltage variation, -10 to +10% of nominal with full output.

.4 All VFDs shall be plenum rated.

.5 All panels shall be marked for their short circuit current rating in compliance with UL.

.8 Quality Assurance

.1 To ensure quality, the VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

.9 Submittals

.1 This specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

.10 Execution

.1 Start-up Service

.1 The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

.2 Warranty

.1 The VFD shall be warranted by the manufacturer for a period of 36 months from initial start-up or 42 months from date of shipment, whichever is less. The warranty shall include replacement equipment or parts as well as a labor allowance for expenses incurred by the manufacturer to provide factory authorized on-site service.

2.32 MATRIX HARMONIC FILTER

.1 The harmonic filter shall be a Matrix AP Filter as manufactured by MTE Corporation.

.2 2The harmonic filter shall treat all characteristic low frequency harmonics generated by a three phase full wave converter load (5th, 7th, 11th, 13th, etc.)

.3 The characteristic harmonics shall be suppressed without need for individual tuning or the requirement to phase shift against other harmonic sources.

.4 The harmonic filter shall be an adaptive passive series connected low pass filter consisting of an inductor capacitor network. Active electronic components shall not be used.

.5 The harmonic filter model supplied shall be capable of feeding a three phase input rectifier with or without line reactors, with or without a DC link choke, with or without a combination line reactor and DC link choke.

.6 The harmonic filter model supplied shall be capable of feeding a rectifier composed of diodes, thyristors or any combination thereof.

.7 The harmonic filter shall meet the harmonic performance specification with a three percent phase voltage unbalance as defined in ANSI C-84.1-1995.

.8 The harmonic filter shall not resonate with the power distribution system nor attract harmonics from other sources.

.9 The filter shall be suitable for use with either a single nonlinear load or multiple nonlinear loads

.10 The filter shall be listed per UL-508.

.11 In the operating range from full load to 30% load the power factor shall be .98 lagging to .85 leading.

.12 The harmonic filter in combination with the adjustable frequency drive shall meet all requirements specified in the 1992 edition of IEEE standard 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals of the harmonic filter.

.13 Total Demand Distortion (TDD) of the current at the input terminals of the harmonic filter shall not exceed the limits defined in Table 10-3 of IEEE-519.

.14 Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10-2 of IEEE-519. The harmonic filter supplier shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.

.15 The harmonic filter shall suppress the characteristic harmonics to the levels specified in paragraph 13.0 provided that the line voltage unbalance is between 0% and 1%. If the line voltage unbalance is between 1% and 3% per ANSI C84.1-1995 the total harmonic input current distortion at any reduced load or speed condition shall not exceed the full load THID by more than 50% (i.e. if 5%THID required at full load, then not more than 7.5% THID at reduced load when voltage unbalance is more than or equal to 1% and less than or equal to 3%.)

.16 The full load efficiency of the harmonic filter shall be greater than 97 percent.

.17 When fed from a power distribution system operating at the nominal distribution voltage, the harmonic filter output voltage at no load shall not be more than 4.6 percent of the nominal RMS and peak distribution voltage.

.18 When fed from a power distribution system operating at the nominal distribution voltage, the harmonic filter output voltage at full load shall not be less than the nominal RMS utilization voltage.

.19 All wiring shall be copper.

.20 To assure that voltage source PWM inverters do not experience over voltage trips, the harmonic filter shall not cause the inverter bus voltage to increase by more than 5% when the filter is operating from the nominal distribution voltage.

.21 To assure that the filter will not reduce the life of a voltage source inverter’s bus capacitor, the output current waveform of the harmonic filter and the input current waveform of the inverter shall be consistent with the input waveform of an inverter fed from a drive equipped with a 3% minimum impedance line reactor.

.22 The harmonic filter shall be handled, stored and installed in accordance with the manufacturer's recommended installation practices as found in the manufacturer's User Manual. Installation shall comply with all applicable local codes.

.23 To assure quality control and proper performance, the filter shall be manufactured by an ISO9001 supplier in the supplier's own manufacturing facility, and not by a contract manufacturer. Filters shall be subject to rigorous quality control checks prior to shipment.

.24 The harmonic filter shall be warranted to be free of defects in materials and workmanship for a period of three years from the date of shipment when applied in accordance with the manufacturer's recommended installation procedures.

.25 An integrated series and shunt reactor shall be used in the construction of the harmonic filter.

.26 To ensure generator compatibility, the harmonic filter must never introduce a capacitive reactive power (KVAR), which is greater than 20% of its KVA rating.

.27 THiD shall be less than 5% at full load and less than 8% at 30% load.

.28 Harmonic filters 320A and above shall be temperature rated to 45 degrees C ambient without performance derating.

.29 NEMA 3R enclosures to be RAL 9003 White with available rodent screens to minimize the effect of solar heating.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air handling equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Provide appropriate protection apparatus.

.2 Install units in accordance with manufacturer's instructions and as indicated.

.3 Ensure adequate clearance for servicing and maintenance.

3.3 FANS

.1 Install fan sheaves required for final air balance.

.2 Install flexible connections at fan inlet and fan outlets.

.3 Install vibration isolators.

3.4 DRIP PANS

.1 Install deep seal P-traps and trap seal primer on drip lines.

.1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.6 INSTALLATION

.1 Install units on a flat surface level within 1/8" and of sufficient strength to support the units.

.2 Provide components furnished as per manufacturer's literature.

.3 Provide all water piping so water circuits are serviceable, without having to dismantle excessive lengths of pipe.

.4 Provide valves in water piping upstream and downstream of each coil for isolating the coils for maintenance and to balance and trim the system.

.5 Provide drain valves and vent cocks to each coil.

.6 Provide strainers ahead of all pumps and automatic modulating valves.

.7 Provide certified wiring schematics to the electrical division for the equipment and controls.

.8 Provide all necessary control wiring as recommended by the manufacturer.

.9 Provide condensate traps in accordance with manufacturers recommendations.

.10 Provide drain lines from unit drain connections to floor drain.

3.7 MANUFACTURERS SERVICES

.1 Manufacturer shall provide three days of supervision to installing contractor, to supervise installation of air handler in mechanical room. Labour to be provided by installing contractor.

.2 Manufacturer shall provide a qualified technician to commission the controls of the unit and provide a report on the operation of the unit. Field wiring of control interlocks to be provided by installing contractor. Installing contractor to include programming of existing building controls to interface with the AHU controller. Mechanical startup of the unit to be provided by installing contractor.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 73 11 Air Handling Units - Packaged

1.2 REFERENCE STANDARDS

.1 ETL, C-ETL

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for humidifiers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC.

.2 Submit shop drawings to indicate project layout, dimensions and extent of humidification system.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.6 Manufacturer's Field Reports:

.1 Submit manufacturer's field reports specified.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for humidifiers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions 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.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect humidifiers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PACKAGED, ELECTRIC, STEAM GENERATOR HUMIDIFIER

.1 Free standing, electric steam humidifiers as shown on Drawings.

.2 Components housed in factory fabricated UL/CSA listed enclosure cabinet with access panel and factory baked enamelled finish. Vapourizing chamber, cover fittings to be stainless steel with heli-arc welded seams.

.3 Controls:

.1 Solid state panels with automatic fill and level sensing and self diagnosis controls. Numeric display of setpoint, measured humidity, high limit setpoint, air proving. Keypad control for setpoint adjustments.

.2 Low water cutoff and skimmer bleed-off functions. Solenoid valve on water, skimmer and drain lines.

.3 Room mounted humidistat.

.4 Airflow proving switch.

.5 Adjustable flush cycle timer, surface skimmer with field adjustable flow control.

.4 Duct distribution header complete with condensate drain and supply hose.

.5 Capacity: as indicated

.6 Standard of Acceptance: Dri-Steem Model 75-3, Nortec, Armstrong.

2.2 GENERAL

.1 Humidifier shall be vaporstream electric evaporative steam humidification system.

.2 Fabrication requirements:

.1 Tank and cover: 14- and 12-gauge 304-stainless steel with Heli-arc welded seams

.2 Quick removable cover with threaded knobs and gasketed flanges

.3 Heater cover interlock safety switch: A factory-mounted and wired interlock safety switch shall de-energize the heaters when the heater cover is removed.

.4 Terminal strip to allow all control wiring connections at the humidifier to be made in a single location

.5 Easily accessible cleanout plate

.6 Steam outlet on top of tank cover to connect to hose, pipe or flange connection

.3 Immersion heater(s): Heater(s) shall be Incoloy alloy-sheathed resistance type designed for no more than 86 watts per square inch. Two threaded ends of each heater element shall pass through the top of the evaporating chamber and be secured and sealed with washer and threaded nuts to evaporating chamber.

.1 Temperature sensor: A factory mounted sensor, with a temperature range of -40 to 248 °F (-40 to 120 °C) shall be mounted on the humidifier to enable the following functions:

.2 Maintain the evaporating chamber water temperature above freezing

.3 Maintain a user-defined preset evaporating chamber water temperature

.4 Allow rapid warm-up of water in evaporating chamber after a call for humidity, providing 100% operation until steam production occurs

.4 Provide backup over-temperature protection for the over-temperature switch

.5 Over-temperature switch: A factory-mounted and -wired UL-listed limit control sensor with manual reset shall sense an over-temperature condition and de-energize heater circuit controls.

.6 Mounting: Humidifier shall be mounted on a pair of trapeze hangers with 3/8" threaded steel rods, hardware and two predrilled pieces of angle iron (models 6-1 through 100-4), or the humidifier shall be mounted on a provided angle-iron suspension structure (models 2-1 through 5-1).

.7 Water requirements: The humidifier shall be capable of generating steam from tap, softened or DI/RO water.

.8 Drain: An electric drain valve shall be mounted on humidifier assembly to allow tank to drain automatically at the end of a humidification season (standard water models only).

2.3 Humidifier Options

.1 Fabrication options:

.1 Tank and cover shall be 316 stainless steel with Heli-arc welded seams.

.2 Factory insulation: Humidifier shall be covered with 1"-thick (25 mm), rigid, foil-faced fiberglass insulation. All surfaces except front face panel and heater terminal cover shall have insulation.

.3 Seismic Certification option: Humidifier shall meet OSHPD Special Seismic Certification Preapproval
for S_{DS} = 2.5 g (floor mount or weather cover only). Includes seismic leg assembly and mounting hardware.

.4 Humidifier shall meet IBC 2009 Seismic Qualification by shake table testing for a S_{DS} = 2.5 g (floor mount or weather cover only). Includes seismic leg assembly and mounting hardware.

.2 Mounting options:

.1 Support legs: Humidifier shall have four painted angle-iron support legs that provide 24" (610 mm) minimum clearance between underside of humidifier and floor (not available for single-heater models).

.3 Options for use with DI water:

.1 Humidifier shall have a stainless steel manually operated drain valve and a stainless steel float operated fill valve (standard on DI/RO models).

.2 Humidifier shall have a stainless steel electric operated drain valve and a stainless steel float operated fill valve with an electric solenoid to prevent tank from filling when the tank drains automatically at the end of a humidification season.

2.4 Humidifier Controls

.1 Time-proportioning (TP) modulation control: The humidifier shall cycle a single output on and off corresponding to an input demand signal.

.2 Control cabinet: NEMA-12 control cabinet shall be shipped loose. An ETL/C-ETL listed control cabinet assembly comprising control devices shall be mounted on a subpanel. Control devices shall include a Vapor-logic®4 microprocessor control system, a magnetic contactor for each heating stage, a control circuit transformer, a fuse set for each heating stage (for multiple heat stages only), a numbered terminal strip, and all interconnecting wiring. All wiring diagrams shall be included in the control cabinet.

.3 Vapor-logic4 microprocessor controller with the following features or functions:

.1 Web interface and server, included standard on all models:

.1 Web interface shall have same functionality as Vapor-logic4 keypad/display

.2 Web interface shall allow multiple remotely located users to simultaneously view system operation and/or change system parameters.

.3 Web interface shall have password-protected secure access.

.4 Web interface shall be compatible with standard Internet browsers.

.5 Web interface shall connect directly to a personal computer or through a system network via Ethernet cable.

.1 Automatic cable configuration shall allow straight-through or crossover cables.

.2 Interoperable with any Modbus® network

.3 Redundant over-temperature safety control

.4 Fully modulating (0% to100%) control of humidifier outputs

.5 PID control capability with field-adjustable settings

.6 Water level control for softened or hard water:

.1 Automatic refill, low water cutoff, field-adjustable skimmer bleedoff functions and automatic drain-down of humidifier. System shall consist of:

.1 A water level sensing unit comprised of three metallic probes screwed into a threaded probe head. Probe head shall incorporate probe isolation chamber to eliminate short-circuiting between probes caused by mineral coating of probe head. Probe head shall be mounted on the humidifier assembly.

.2 A solenoid operated fill valve factory mounted on the humidifier assembly

.3 End-of-season drain automatically drains humidifier tank after a user-defined period of system inactivity.

.7 Temperature sensor: A factory mounted sensor, with a temperature range of -40 to 248 °F (-40 to 120 °C) mounted on the humidifier to enable the following functions:

.1 Maintain the evaporating chamber water temperature above freezing

.2 Maintain a user-defined preset evaporating chamber water temperature

.3 Allow rapid warm-up of water in evaporating chamber after a call for humidity, providing 100% operation until steam production occurs

.8 USB port on the control board for software updates, data backups, and data restoration

.9 Up-time optimizer function to keep humidifier(s) operating through conditions such as fill, drain, or run-time faults, as long as safety conditions are met, minimizing production down-time

.10 Real-time clock to allow time-stamped alarm/message tracking, and scheduled events

.11 Factory commissioning of humidifier and control board, including system configuration as-ordered

.12 Keypad/display operable within a temperature range of 32 to 158 °F (0 to 70 °C), and that provides backlighting for viewing in low light

.13 Alarms, unit configuration, and usage timer values shall remain in nonvolatile memory indefinitely during a power outage.

.14 The capability to monitor, control, and/or adjust the following parameters:

.1 Relative humidity (RH) set point, actual conditions in the space (from humidity transmitter), RH offset

.2 Dew point set point, actual conditions in the space (from dew point transmitter), dew point offset

.3 Relative humidity (RH) duct high limit set point (switch) and actual conditions

.4 Relative humidity (RH) duct high limit set point, actual conditions (from transmitter), high limit span, and high limit offset

.5 Total system demand in % of humidifier capacity

.6 Total system output in lbs/hour (kg/h)

.7 Drain/flush duration

.8 End-of-season drain status (on standard water systems and if ordered as a DI water option) and hours humidifier is idle before end of season draining occurs

.9 Window glass surface temperature (in % RH offset application using sensor ordered as an option) with programmable offset

.10 Air temperature or other auxiliary temperature monitoring with programmable offset (using sensor ordered as an option)

.11 System alarms and system messages, current and previous

.12 Adjustable water skim duration

.13 Programmable outputs for remote signaling of alarms and/or messages, device activation (such as a fan), or for signaling tank heating and/or steam production

.14 System diagnostics that include:

.1 Test outputs function to verify component operation

.2 Test humidifier function, by simulating demand to validate performance

.3 Data collection of RH, air temperature, water use, energy use, alarms, and service messages for viewing from the keypad/display or Web interface

.15 Service notification scheduling

.16 Password-protected system parameters

.17 Keypad/display or Web interface displays in English, French, or German languages

.18 Numerical units displayed in inch-pound or SI units

2.5 Humidifier Control Options

.1 Interoperability using BACnet MS/TP.

.2 Multiple humidifier tank control. Vapor-logic4 shall be programmed and configured at the factory to control multiple humidifier tanks. Controller functions shall include all Vapor-logic4 functions listed above plus:

.1 The controller shall control up to 16 humidifier tanks.

.2 Automatic run-time balancing. The controller shall assign duty to all humidifier tanks in the multi-tank group such that each humidifier accrues approximately the same hours of duty, thereby ensuring equal wear across all humidifiers in the multi-tank group.

.3 One humidifier tank shall be capable of being controlled as a redundant tank.

.4 One Vapor-logic4 keypad/display shall be included with each multi-tank group.

.3 Control cabinet options:

.1 Mounted on humidifier: NEMA-12 control cabinet shall be factory attached to the side of humidifier with all wiring between cabinet and humidifier completed at factory. An ETL/C-ETL listed control cabinet assembly comprising control devices shall be mounted on a subpanel. Control devices shall include a Vapor-logic4 microprocessor control system, a magnetic contactor for each heat stage, a control circuit transformer, a fuse set for each heating stage (for multiple heat stages only), a numbered terminal strip, and all interconnecting wiring. A wiring diagram shall be included in the control cabinet.

.2 Cabinet door interlock switch: The control cabinet shall have an interlock control switch with manual override to remove control voltage when door is opened.

.3 Cabinet door lock: Control cabinet shall have a lock with keys provided.

.4 Water level control for DI/RO water:

.1 System shall provide for continuous control of water level and will accommodate the use of deionized or reverse osmosis water with resistance up to 18 M-ohm/cm.

.2 System shall:

.1 Have a water level sensing unit comprised of a float operated stainless steel valve for water makeup

.2 Have a low water cutoff float switch

.3 Operate within inlet water pressure range of 25 to 80 psi (172 to 552 kPa)

.5 Remote keypad option: Provide a keypad with cable for remote mounting. Available cable lengths: 10’ (3 m), 25' (7.6 m), 50' (15 m), 100' (30 m), or 500' (152 m)

.6 Keypad mounted on cabinet option: The keypad shall be factory mounted on the side of the control cabinet.

.7 Control output options:

.1 100% SSR modulation control option: The humidifier shall have all humidifier heat stages modulating through electronic power controllers, which provide a total 0% to 100% modulation of humidifier output. All SSR controls are mounted and wired through the cabinet door.

.8 Control input accessory options:

.1 Humidity transmitter, room: Humidity transmitter shall be a room-mounted device that measures from 0% to 100% of RH range and provides a linear output (10% to 90% RH) from 4 to 20 mA. Accuracy ± 2% RH. Supply voltage 21 VDC. Operating temperature range: -4 to 140 °F (-20 to 60 °C).

.2 Dew point transmitter: A dew point transmitter (duct- or room-mounted) shall measure the humidity and temperature in the environment and then compute the dew point. Output 4 to 20 mA (700 ohms maximum). Supply voltage 24 VDC. Operating temperature range when duct-mounted: -40 to 185 °F (-40 to 85 °C). Operating temperature range when room-mounted: 32 to 122 °F (0 to 50 °C).

.3 Auxiliary temperature sensor/transmitter: Auxiliary temperature sensor and transmitter shall allow air temperature monitoring, such as in a duct, and shall enable temperature compensation to prevent window condensation. Temperature transmitter, operating temperature range -20 to 160 °F (-29 to 71 °C), shall be provided for field installation. Transmitter shall supply its signal (4 to 20 mA) to the microprocessor control system, which shall lower the indoor RH set point to a level 5% or more below the dew point temperature during a cold spell, thus preventing window condensation. The indoor RH shall be automatically returned to the normal setting when the glass temperature rises.

.4 Humidistat, on-off, high limit: Electric humidistat control shall be an on-off style, duct mounted with a control range of 15% to 95% RH. Compatible with 24, 120, and 240 VAC. Operating temperature range 40 to 125 °F (4 to 52 °C).

.5 Airflow proving switch, pressure type: Airflow proving switch shall be diaphragm-operated with pitot tube for field installation. Switch shall have an adjustable control point range of 0.05" to 12" wc (12.5 to 2988 Pa) Operating

temperature range -40 to 180 °F (-40 to 82 °C). Compatible with 24, 120, and 240 VAC.

2.6 Humidifier Accessories

.1 Drane-kooler: A thermostatically controlled water valve shall meter an amount of cold water into a stainless steel mixing chamber to temper 212 °F (100 °C) water with a 6 gpm (0.38 l/s) in-flow rate to a 140 °F (60 °C) discharge temperature to sanitary system.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for humidifiers installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Humidifier to be new and clean when project is accepted.

.3 Install humidistat as indicated.

.4 Water service overflow drain: to manufacturers' recommendation.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Manufacturer's Field Services: 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, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Workat 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit immediately to Consultant.

.2 Performance Verification (PV):

.1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.

.2 Timing:

.1 After TAB of ducted air systems.

.2 At same time as PV of related air handling units.

.3 PV procedures:

.1 Packaged Electric Steam Generating Type

.4 Electric steam generator.

.3 Start-up:

.1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.

.2 Verify:

.1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.

.2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the duct system.

.3 Visually check distribution manifold to ensure:

.1 Even distribution of vapour.

.2 Freedom from water deposits.

.4 Commissioning Reports:

.1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified. Include:

.1 PV results on approved PV Report Forms.

.2 Product Information Report Forms.

3.4 DEMONSTRATION

.1 Training: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 Summary

.1 Section Includes

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) includes:

.1 Start-up testing and verification of systems.

.2 Check out demonstration or proper operation of components.

.3 On-site operational tests.

.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 78 00 - Closeout Submittals

.3 Section 01 91 13 General Commissioning Requirements

1.2 Definitions

.1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

.2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS Contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.3 Design Requirements

.1 Confirm with Engineer that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.4 Submittals

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

.2 Final Report: submit report to Engineer.

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by Engineer before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Engineer in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.5 Closeout Submittals

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Engineer before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.6 Commissioning

.1 Carry out commissioning under direction of Engineer and in presence of Engineer and building manager.

.2 Inform, and obtain approval from, Engineer in writing at least 14 days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

.3 Correct deficiencies, re-test in presence of Engineer until satisfactory performance is obtained.

.4 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.5 Load system with project software.

.6 Perform tests as required.

1.7 Completion of Commissioning

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Engineer and Building Manager.

1.8 Issuance of Final Certificate of Completion

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 Products

2.1 Equipment

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.

.4 Locations to be approved, readily accessible, and readable.

.5 Application: to conform to normal industry standards.

Part 3 Execution

3.1 Procedures

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Engineer.

.3 Commission integrated systems using procedures prescribed by Engineer.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 Field Quality Control

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Engineer.

.3 Configure major components to be tested in same architecture as existing designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 VAV supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.2 Completion Testing.

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Engineer. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Engineer and Building Manager:

.1 Provide technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Engineer acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final startup testing.

.5 O&M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel and Engineer.

.7 Operate systems as long as necessary to commission entire project.

.8 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure

proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 30 consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 Engineer to verify reported results.

3.3 Adjusting

.1 Final adjusting: upon completion of commissioning as reviewed by Engineer, set and lock devices in final position and permanently mark settings.

3.4 Demonstration

.1 Demonstrate to Engineer operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

Part 1 General

1.1 Summary

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

1.2 References

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).

.1 ANSI/ISA 5.5-[1985], Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

.1 ANSI/IEEE 260.1-[1993], American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE STD 135-[R2001], BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).

.1 CAN/CSA-Z234.1-[89(R1995)], Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).

.1 CEA-709.1-[B-2002], Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).

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

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.7 Electrical and Electronic Manufacturers Association (EEMAC).

.1 EEMAC 2Y-1-[1958], Light Gray Colour for Indoor Switch Gear.

.8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

1.3 Acronyms and Abbreviations

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level.

.2 AI - Analog Input.

.3 AIT - Agreement on International Trade.
.4 AO - Analog Output.
.5 BACnet - Building Automation and Control Network.
.6 BC(s) - Building Controller(s).
.7 BECC - Building Environmental Control Center.
.8 CAD - Computer Aided Design.
.9 CDL - Control Description Logic.
.10 CDS - Control Design Schematic.
.11 COSV - Change of State or Value.
.12 CPU - Central Processing Unit.
.13 DI - Digital Input.
.14 DO - Digital Output.
.15 DP - Differential Pressure.
.16 ECU - Equipment Control Unit.
.17 EMCS - Energy Monitoring and Control System.
.18 HVAC - Heating, Ventilation, Air Conditioning.
.19 IDE - Interface Device Equipment.
.20 I/O - Input/Output.
.21 ISA - Industry Standard Architecture.
.22 LAN - Local Area Network.
.23 LCU - Local Control Unit.
.24 MB – Dual Duct Mixing Box
.25 MCU - Master Control Unit.
.26 NAFTA - North American Free Trade Agreement.
.27 NC - Normally Closed.
.28 NO - Normally Open.
.29 OS - Operating System.
.30 O&M - Operation and Maintenance.
.31 OWS - Operator Work Station.
.32 PC - Personal Computer.
.33 PCI - Peripheral Control Interface.
.34 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.35 PID - Proportional, Integral and Derivative.
.36 RAM - Random Access Memory.
.37 SP - Static Pressure.
.38 ROM - Read Only Memory.
.39 TCU - Terminal Control Unit.
.40 USB - Universal Serial Bus.
.41 UPS - Uninterruptible Power Supply.
.42 VAV or VV - Variable Air Volume.

1.4 Definitions

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.

.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.

.1 Area descriptor: building or part of building where point is located.

.2 System descriptor: system that point is located on.

.3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.

.2 Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.

.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:

.1 AI (analog input).

.2 AO (analog output).

.3 DI (digital input).

.4 DO (digital output).

.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.

1.5 System Description

.1 Refer to existing control schematics for system architecture. The work consists of modifications, renovations and additions to the existing systems.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.

.2 Control devices as listed in I/O point summary tables.

.3 OWS(s).

.4 Data communications equipment necessary to effect EMCS data transmission system.

.5 Field control devices.

.6 Software/Hardware complete with full documentation.

.7 Complete operating and maintenance manuals.

.8 Training of personnel.

.9 Acceptance tests, technical support during commissioning, full documentation.

.10 Wiring interface co-ordination of equipment supplied by others.

.11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:

.1 Design and provide conduit and wiring linking elements of system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Engineer prior to installation.

.3 Location of controllers as reviewed by Engineer prior to installation.

.4 Provide utility power to EMCS as indicated.

.5 Metric references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements:

.1 Provide English operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals.

.3 Operating system executive: provide primary hardware-to-software interface with associated documentation to be in English.

.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.5 Include, in English:

.1 Input and output commands and messages from operator-initiated functions, field related changes, alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in French and English at specified OWS and to be able to operate one terminal in English.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 Action and Informational Submittals

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

.2 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available, submit such equipment to CSA inspection authorities for special inspection and CSA approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Engineer, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to Engineer.

.8 Existing devices intended for re-use: submit test report.

1.7 Quality Assurance

.1 Have local office within 50km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,

.2 All DDC controls shall be the same as existing and installed by an authorized dealer and contractor installer.

.3 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

.4 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.

.5 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.6 Standard of Acceptance: Reliable Controls or an acceptable alternative in construction and performance approved by the Engineer.

.7 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.8 Existing Conditions - Control Components

.1 Utilize existing control wiring and temperature sensors as indicated.

.2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.

.1 Do not modify original design of existing devices without written permission from Engineer.

.2 Provide for new, properly designed device where re-usability of components is uncertain.

.3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.

.1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Engineer.

.2 Failure to produce test report will constitute acceptance of existing devices by contractor.

.4 Non-functioning items:

.1 Provide with report specification sheets or written functional requirements to support findings.

.2 Engineer will repair or replace existing items judged defective yet deemed necessary for EMCS.

.5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.

.6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Engineer.

.1 Be responsible for items repaired or replaced by Engineer.

.2 Be responsible for repair costs due to negligence or abuse of equipment.

.3 Responsibility for existing devices terminates upon final acceptance of EMCS applicable portions of EMCS as approved by Engineer.

.7 Remove existing controls, wiring, and pneumatic lines not re-used or not required. Place in approved storage for disposition as directed.

Part 2 Products

2.1 Equipment

.1 Control Network Protocol and Data Communication Protocol: to ASHRAE STD 135.

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

2.2 Adaptors

.1 Provide adaptors between metric and imperial components.

2.3 Acceptable Products: Reliable Controls

Part 3 Execution

3.1 Manufacturer's Recommendations

.1 Installation: to manufacturer's recommendations.

.2 Installation to be by a local Reliable Controls authorized dealer and contractor installer.

3.2 Painting

.1 Painting: as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors.

END OF SECTION

Part 1 General

1.1 Summary

.1 Section Includes

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures

.2 Section 25 05 01 - EMCS: General Requirements

1.2 Definitions

.1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 Design Requirements

.1 Preliminary Design Review: to contain following contractor and systems information.

.1 Location of local office.

.2 Description and location of installing and servicing technical staff.

.3 Location and qualifications of programming design and programming support staff.

.4 List of spare parts.

.5 Location of spare parts stock.

.6 Names of sub-contractors and site-specific key personnel.

.7 Sketch of site-specific system architecture.

.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.

.9 Descriptive brochures.

.10 Sample CDL and graphics (systems schematics).

.11 Response time for each type of command and report.

.12 Item-by-item statement of compliance.

.13 Proof of demonstrated ability of system to communicate utilizing Proprietary Communications Protocol or BACnet.

.14 Proof of being an authorized Reliable Controls dealer and contractor installer.

1.4 Action and Informational Submittals

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within 5 working days after contract award, for review by Engineer.

.3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

.4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.5 Soft copy to be in AutoCAD – latest version and Microsoft Word – latest version format, structured using menu format for easy loading and retrieval on OWS.

1.5 Preliminary Shop Drawing Review

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Discharge air sensors

.8 Humidity sensors

1.6 Detail Shop Drawing Review

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.4 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Complete Point Name Lists.

.5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.6 Software and programming details associated with each point.

.7 Manufacturer's recommended installation instructions and procedures.

.8 Input and output signal levels or pressures where new system ties into existing control equipment.

.5 Control schematics, narrative description, CDLs fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.6 Graphic system schematic displays of air systems with point identifiers and textual description of system, and typical floor plans as specified.

.7 Complete system CDLs including companion English language explanations on same sheet but with different font and italics. CDLs to contain specified energy optimization programs.

.8 Listing and example of specified reports.

.9 Listing of time of day schedules.

.10 Type and size of memory with statement of spare memory capacity.

.11 Full description of software programs provided.

.12 Sample of "Operating Instructions Manual" to be used for training purposes.

.13 Outline of proposed start-up and verification procedures.

1.7 Quality Assurance

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between contract document requirements and actual items. Review interface requirements of materials supplied by others.

.3 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 Engineer retains right to revise sequence or subsequent CDL prior to software finalization without cost to Engineer.

Part 2 Products

2.1 Not Used

.1 Not used

Part 3 Execution

3.1 Not Used

.1 Not used

END OF SECTION

Part 1 General

1.1 Summary

.1 Section Includes

.1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

.2 Related Sections

.1 Section 01 78 00 - Closeout Submittals
.2 Section 25 05 01 - EMCS: General Requirements
.3 Section 25 05 02 - EMCS: Submittals and Review Process

1.2 Definitions

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 Submittals

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Submit Record Documents and Operation and Maintenance Manual to Engineer in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3-ring, D-ring binders.

.1 Binders to be 2/3 maximum full.
.2 Provide index to full volume in each binder.
.3 Identify contents of each manual on cover and spine.
.4 Provide Table of Contents in each manual.
.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 As-Builts

.1 Provide 1 copy of detailed shop drawings and include:

.1 Changes to contract documents as well as addenda and contract extras.
.2 Changes to interface wiring.
.3 Routing of conduit and wiring associated with EMCS installation.
.4 Locations of obscure devices to be indicated on drawings.
.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports.

.9 Basic system design and full documentation on system configuration.

.10 Revisions to existing programming including new room numbers shown on site and on drawings.

.2 Submit for final review by Engineer.

.3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

1.5 O&M Manuals

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics, or in-depth control theory.

.4 Functional description to include:

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented [or planned] for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, and program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Revisions to existing programming including new room numbers shown on site and on drawings.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware, plus diagnostics and repair or replacement of system hardware.

.8 System configuration document:

.1 Provisions and procedures for planning, implementing, and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure coordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, and fully commented source listing of applicable driver/handler.

Part 2 Products

2.1 Not Used

.1 Not used

Part 3 Execution

3.1 Not Used

.1 Not used

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - EMCS: General Requirements.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.1-[02], The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Engineer for approval samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3mm thick matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67mm minimum.

.3 Lettering: minimum 7mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain plastic tie.

.2 Sizes: 50 x 100mm minimum.

.3 Lettering: minimum 5mm high produced from laser printer in black.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Engineer.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Engineer's.

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm colour with Engineer during "Preliminary Design Review".

Part 3 Execution

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during Work.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)

.1 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.

.2 ANSI C2-1990, National Electrical Safety Code.

.3 ANSI/NFPA 70-1990, National Electrical Code.

.2 CSA Group

.1 CSA C22.1-12,

.2 CAN/CSA-C22.3 No. 7-10, Underground Systems.

.3 CSA C22.2 No. 45.1-07(R2012), Electrical Rigid Metal Conduit.

.4 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.5 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.

.6 CAN/CSA-C22.3 No. 1-10, Overhead Systems.

1.2 SYSTEM DESCRIPTION

.1 Electrical:

.1 Provide power wiring from existing power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

.2 Hard wiring between field control devices and EMCS field panels.

.3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.

.4 Modify existing starters to provide for EMCS.

.5 Refer to wiring diagrams included as part of flow diagrams.

.2 Pneumatic:

.1 Pneumatic tubing, valves and fittings for field control devices.

.3 Mechanical:

.1 Pipe Taps Required for EMCS equipment will be supplied and installed by EMCS Contractor.

.2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by EMCS Contractor.

.3 Installation of dampers, and other devices requiring sheet metal trades to be mounted by EMCS Contractor. Costs to be carried by designated trade.

.4 Structural:

.1 Special steelwork as required for installation of work.

1.3 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

.1 Continuously direct and monitor all work.

.2 Attend site meetings.

1.4 EXISTING CONDITIONS

.1 Cutting and Patching: This is the responsibility of EMCS Contractor to do this work.

.2 Repair all surfaces damaged during execution of work.

.3 Turn over to Consultant existing materials removed from work not identified for re-use.

Part 2 Products

2.1 SPECIAL SUPPORTS

.1 Structural grade steel, primed and painted after construction and before installation.

2.2 PIPING FOR PNEUMATIC CONTROL SYSTEMS

.1 Copper:

.1 Tubing:

.1 Fittings: wrought copper solder type to ANSI/ASME B16.22, and 95.5 antimonial tin solder. At instruments use compression fittings.

.2 At panels and junction boxes where there is a transition from plastic to copper use bulkhead fittings.

.2 Plastic:

.1 Flame retardant, black PVC with minimum burst strength 1.3 MPa at 23 degrees Celsius installed in conduit.

.2 Fittings: compression type as required.

2.3 WIRING

.1 As per requirements of Division 26.

.2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:

.1 120V Power supply: to match or exceed breaker, size #12 minimum.

.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.

.3 Field wiring to digital device: #18 AWG stranded twisted pair.

.4 Analog input and output: shielded #18 minimum solid copper. Wiring must be continuous without joints.

.5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations:

.1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.4 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.

.3 Junction and pull boxes: welded steel.

.1 Surface mounting cast FS: screw-on flat covers.

.2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:

.1 Bushings and connectors: with nylon insulated throats.

.2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:

.1 Couplings and fittings: threaded type steel.

.2 Double locknuts and insulated bushings: use on sheet metal boxes.

.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

2.5 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 Receptacles:

.1 Duplex: CSA type 5-15R.

.2 Single: CSA type 5-15R.

.3 Cover plates and blank plates: finish to match other plates in area.

2.6 STARTERS, CONTROL DEVICES

.1 Across-the-line magnetic starters:

.1 Enclosures: CSA Type 1, except where otherwise specified.

.2 Size, type and rating: to suit motors.

.2 Starter diagrams:

.1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.

.3 Auxiliary Control Devices:

.1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.

.2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.

.3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.

.4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

.4 Finish for starters:

.1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Interior: white.

2.7 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:

.1 50 mm diameter and smaller: one-hole steel straps.

.2 Larger than 50 mm diameter: two-hole steel straps.

.3 Suspended support systems:

.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.

.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 MECHANICAL PIPING

.1 Install piping straight, parallel and close to building structure with required grades for drainage and venting.

.2 Ream ends of pipes before assembly.

.3 Copper tubing not to come into contact with dissimilar metal.

.4 Use non-corrosive lubricant or Teflon tape on male screwed threads.

.5 Clean ends of pipes, tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.

.6 Install di-electric couplings where dissimilar metals joined.

.7 Sleeves:

.1 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint.

.2 Caulking:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere: provide space for fire stopping by Section 07 84 00 – Fire Stopping. Maintain fire rating integrity.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

.8 Pressure tests:

.1 Pressure test all piping systems modified under this contract to 1 1/2 times maximum working pressure or 860 kPa (whichever is greater) for 4 hours without loss of pressure.

.2 Isolate equipment, components, not designed to withstand test pressure.

.9 Introduce system pressure carefully into new piping.

3.3 SUPPORTS

.1 Install special supports as required and as indicated.

3.4 PNEUMATIC CONTROL SYSTEMS

.1 General:

.1 Install tubing in accessible concealed locations, straight, parallel and close to building structure with required grades for drainage and venting.

.2 Install drip legs and drains at low points.

.3 Tubing to be free from surface damage.

.4 Tubing NOT to pass through or touch unheated ducts or enclosures.

.5 Do not cover pneumatic tubing with insulation.

.6 Test tubing, check joints after connection to system.

.2 Copper tubing:

.1 Not to come into contact with dissimilar metal. Use non-metallic stand-offs on air handling systems.

.2 Install dielectric couplings where dissimilar metals are connected.

.3 Plastic tubing:

.1 Inaccessible locations: install plastic tubing in conduit.

.2 Inside panels: install in tube trays or racks, or clip individually to back of panel.

.3 Multiple tube bundles: install in tube trays, conduit or armoured flexible cable.

3.5 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

.1 Division 26, this specification.

.2 CSA 22.1 Canadian Electrical Code.

.3 ANSI/NFPA 70.

.4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.

.3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, and sleeves prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.6 CONDUIT SYSTEM

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.

.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Consultant Departmental Representative DCC Representative before starting such work. Provide complete conduit

system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:

.1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

.2 Provide adequate support for raceways and cables, sloped vertically to equipment.

.3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Consultant.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of Consultant's written approval.

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:

.1 Install in inconspicuous but accessible locations.

.2 Support boxes independently of connecting conduits.

.3 Fill boxes with paper or foam to prevent entry of construction material.

.4 Provide correct size of openings. Reducing washers not permitted.

.5 Mark location of pull boxes on record drawings.

.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install terminal blocks or strips indicated in cabinets to Section 6.

.17 Install bonding conductor for 120 volt and above in conduit.

3.7 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:

.1 Circuits are continuous, free from shorts, unspecified grounds.

.2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Consultant with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.8 WIRING DEVICES, COVER PLATES

.1 Receptacles:

.1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Cover plates:

.1 Install suitable common cover plate where wiring devices are grouped.

.2 Use flush type cover plates only on flush type outlet boxes.

3.9 STARTERS, CONTROL DEVICES

.1 Install and make power and control connections as indicated.

.2 Install correct over-current devices.

.3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.

.4 Performance Verification:

.1 Operate switches and controls to verify functioning.

.2 Perform start and stop sequences of contactors and relays.

.3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.10 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.11 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.

.2 Give 14 days' written notice of intention to test.

.3 Conduct in presence of Consultant and authority having jurisdiction.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Consultant in writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Consultant and authority having jurisdiction.

3.12 IDENTIFICATION

.1 Refer to Section 25 05 54 - EMCS: Identification.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 78 00 - Closeout Submittals.
.3 Section 25 05 01 - EMCS: General Requirements.

.3 References.

.1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
.2 Canadian Standards Association (CSA International).
.1 CSA Z204-[94(R1999)], Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 DEFINITIONS

.1 BC(s) - Building Controller(s).

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to Engineer.

.3 Submit detailed inspection reports to Engineer.

.4 Submit dated, maintenance task lists to Engineer and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.
.2 Device type and range.
.3 Measured value.
.4 System displayed value.
.5 Calibration detail
.6 Indication if adjustment required,
.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to Engineer, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Engineer in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish Engineer with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.

.5 Perform Work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Engineer.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (1) one minor inspection and one major inspection at end of warranty period. Provide detailed written report to Engineer as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and Calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.

.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Review system performance with Engineer to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.1 Test systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for building automation controllers including:

.1 Master Control Unit (MCU).

.2 Local Control Unit (LCU).

.3 Equipment Control Unit (ECU).

.4 Terminal Control Unit (TCU).

.2 Related Sections:

.1 Section 25 05 01 - EMCS: General Requirements.

.2 Section 25 05 02 - EMCS: Submittals and Review Process.

.3 Section 25 05 03 - EMCS: Project Record Documents.

.4 Section 25 30 02 - EMCS: Field Control Devices.

.5 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE [2003], Applications Handbook, SI Edition.

.2 Canadian Standards Association (CSA International).

.1 C22.2 No.205-[M1983(R1999)], Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE C37.90.1-[02], Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Engineer at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.

.1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.

.2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

1.5 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0 - 10 V DC;

.3 100/1000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by Engineer for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Submittals and Review Process.

.1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

Part 2 Products

2.1 MASTER CONTROL UNIT (MCU)

.1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.

.1 MCU must support existing Proprietary Protocol.

.3 MCU local I/O capacity as follows:

.1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.

.2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU).

.1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.

.2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:

.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.

.2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.

.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for HVAC systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points integral to one Building System to be resident on only one controller.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:

.1 Include minimum 2 interface ports for connection of local computer terminal.

.2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.

.1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

.3 Dual Duct Mixing Box / VAV Terminal Controller.

.1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook and Section 25 90 01.

.2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.

.3 Controller to operate independent of network in case of communication failure.

.4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 SOFTWARE

.1 General.

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

.3 Include initial programming of Controllers, for entire system.

.2 Program and data storage.

.1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.

.1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Engineer.

.4 Operator Terminal interface.

.1 Operating and control functions include:

.1 Multi-level password access protection to allow user/manager to limit workstation control.

.2 Alarm management: processing and messages.

.3 Operator commands.

.4 Reports.

.5 Displays.

.6 Point identification.

.5 Pseudo or calculated points.

.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start stop.

.6 Night setback control.

.7 Enthalpy (economizer) switchover.

.8 Peak demand limiting.

.9 Temperature compensated load rolling.

.10 Fan speed/flow rate control.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Engineer.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

Part 3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Consultant.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as directed by Consultant.

.2 Provide necessary power from local 120V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Control devices integral to the Building Energy Monitoring and Control System EMCS: transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, and low voltage current transformers.

.2 Related Sections:

.1 Section 01 73 00 - Execution Requirements.

.2 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.

.3 Section 25 05 01 - EMCS: General Requirements.

.4 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.5 Section 25 05 54 - EMCS: Identification.

.6 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCES

.1 American National Standards Institute (ANSI).

.1 ANSI C12.7-1993(R1999), Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA).

.1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA).

.1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers for Rating.

.5 Canadian Standards Association (CSA International).

.1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

.1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Section 01 73 00 - Execution supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 Legally dispose of existing materials removed from Work not identified for re-use.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight assembly.

.3 Operating conditions: 0 - 32 degrees C with 10 - 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.8 Range: including temperature, humidity, pressure, as indicated in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200 degrees C and over.

.2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.

.2 Room temperature sensors and display wall modules.

.1 Temperature sensing and display wall module.

.1 LCD display to show space temperature and temperature setpoint.

.2 Buttons for occupant selection of temperature setpoint

.3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit.

.4 Integral thermistor sensing element 10,000 ohm at 24 degrees.

.5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.

.6 Stability 0.02 degrees C drift per year.

.7 Separate mounting base for ease of installation.

.2 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed stainless steel finish, with guard.

.2 Element 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.

.3 Sensor to be Reliable SST.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460mm.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000mm. Bend probe at field installation time to 100mm radius at point along probe without degradation of performance.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.

.2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.

.3 Output signal: 4 – 20 mA into 500 ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2% of full scale for supply voltage variation of plus or minus 10%.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full scale output.

.7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0% of full scale/ 50 degrees C.

.10 Long term output drift: not to exceed 0.25% of full scale/ 6 months.

.11 Transmitter ranges: select narrowest range to suit application from following:

.1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.

.2 0 to 100 degrees C, plus or minus 0.5 degrees C.

.3 0 to 50 degrees C, plus or minus 0.25 degrees C.

.4 0 to 25 degrees C, plus or minus 0.1 degrees C.

.5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.4 HUMIDITY SENSORS

.1 Room and Duct Requirements:

.1 Range: 5 - 90 % RH minimum.

.2 Operating temperature range: 0 - 60 degrees C.

.3 Absolute accuracy:

.1 Duct sensors: plus or minus 3 %.

.2 Room sensors: plus or minus 2 %.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.

.6 Room sensors: wall mounted locate in air stream near RA grille as indicated.

.7 Duct mounted sensors: locate so that sensing element is in air flow in duct.

.2 Outdoor Humidity Requirements:

.1 Range: 0 - 100 % RH minimum.

.2 Operating temperature range: -40 - 50 degrees C.

.3 Absolute accuracy: plus or minus 2%.

.4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.

.5 Must be unaffected by condensation or 100% saturation.

.6 No routine maintenance or calibration is required.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

.1 Input signal: from RH sensor.

.2 Output signal: 4 - 20 mA onto 500 ohm maximum load.

.3 Input and output short circuit and open circuit protection.

.4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.

.5 Output linearity error: plus or minus 1.0% maximum of full scale output.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 1.0 % full scale/ 6 months.

.8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.6 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Combined sensor and transmitter measuring pressure.

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 – 20 mA into 50 ohm maximum load.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % full scale output over entire range.

.5 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.

.6 Over-pressure input protection to at least twice rated input pressure.

.7 Output short circuit and open circuit protection.

.8 Accuracy: plus or minus 1 % of Full Scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrumental air, compressed air, water, steam, as applicable.

.2 Output signal: 4 – 2 mA into 50 ohm maximum load.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).

.2 Accuracy: plus or minus 1 % of actual duct static pressure.

2.9 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 – 20 mA linear into 500 ohm maximum load.
.2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow
.3 Accuracy: 0.4 % of span.
.4 Repeatability: within 0.5 % of output
.5 Linearity: within 1.5 % of span
.6 Deadband or hysteresis: 0.1 % of span
.7 External exposed zero and span adjustment
.8 Unit to have 12.5 N.P.T. conduit connection. Enclosure to be integral part of unit.

2.10 VELOCITY PRESSURE SENSORS

.1 Requirements:

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
.2 Maximum pressure loss: 37 Pa at 1000 m/s
.3 Accuracy: plus or minus 1 % of actual dust velocity.

2.11 VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 – 20 mA linear into 500 ohm maximum load.
.2 Calibrated span: not to exceed 125 % of duct velocity pressure at maximum flow.
.3 Accuracy: 0.4 % of span.
.4 Repeatability: within 0.1 % of output
.5 Linearity: within 0.5 % of span
.6 Deadband or hysteresis: 0.1 % of span
.7 External exposed zero and span adjustment.
.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.12 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Internal materials: suitable for continuous contact with compressed air , water, steam, etc. As applicable
.2 Adjustable setpoint and differential
.3 Switch: snap action type, rated at 24 V DC
.4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
.5 Accuracy: within 2% repetitive switching.
.6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
.7 Switches on steam and high temperature hot water service: provide pigtail siphon.

2.13 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:

- .1 Construction: steel, cast iron, aluminum.
- .2 Control signal: 0-10V DC or4-20 mA DC.
- .3 Positioning time: to suit application. 90 sec maximum.
- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
- .8 Minimum shut-off pressure: refer to control valve schedule.

2.14 CONTROL VALVES

.1 Body: globe style.

- .1 Flow characteristic as indicated on control valve schedule: quick opening equal percentage, linear,
- .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
- .3 Normally open, as indicated.
- .4 Three port as indicated.
- .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .6 Packing easily replaceable.
- .7 Stem, stainless steel.
- .8 Plug and seat, stainless steel.
- .9 Disc, replaceable, material to suit application.
- .10 NPS 2 and under:
  - .1 Screwed National Pipe Thread (NPT) tapered female connections.
  - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
  - .3 Rangeability 50:1minimum.
- .11 NPS 2½ and larger:
  - .1 Flanged connections.
  - .2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.
  - .3 Rangeability 100:1minimum.

2.15 WIRING

.1 In accordance with Canadian Electrical Code

.2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring. Exposed wiring shall be run in conduit

.3 Wiring must be continuous without joints.

.4 Sizes:

.1 Field wiring to digital device: #18AWG stranded twisted pair.

.2 Analog input and output: shielded #18 minimum solid copper stranded twisted pair.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.3 Temperature transmitters, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on channel brackets.

.5 Fire stopping: Maintain fire rating integrity.

.6 Electrical:

.1 Complete installation in accordance with Canadian Electrical Code

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Consultant before beginning Work.

.4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.5 Install communication wiring in conduit.

.1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill not to exceed 40%.

.4 Design drawings do not show conduit layout.

.6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Consultant to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 TEMPERATURE SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Duct installations:

- .1 Do not mount in dead air space.
- .2 Locate within sensor vibration and velocity limits.
- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.

.4 Averaging duct type temperature sensors.

- .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
- .2 Wire multiple sensors in series for low temperature protection applications.
- .3 Wire multiple sensors separately for temperature measurement.
- .4 Use software averaging algorithm to derive overall average for control purposes.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

3.4 I/P TRANSDUCERS

.1 Install air pressure gauge on outlet.

3.5 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.6 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.7 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.

.1 Control Description Logic (CDL) for each system.

.2 Input/Output Point Summary Tables for each system.

.3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS).

1.2 SEQUENCING

.1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.

.2 Sequencing of operations for systems as follows:

.1 Existing AHU-3-1 Sequence of Controls

.1 General

.1 Air Handling Unit supplies a variable amount of 100% HEPA filtered outside air to the chemical containment lab 222 as room load and exhaust requirements dictate.

.2 Start/ Stop Control

.1 This unit is programmed to run 24 hours / day, 365 days per year. An adjustable schedule is provided should this operation need to be changed. Should the system be scheduled to be off, it can be returned to the occupied mode from a manual switch located in the Self-Contained Lab lobby entrance. Should the schedule have an unoccupied mode, the system will start for 5 minutes out of every hour to purge any fumes that may have accumulated in the lab. The frequency and duration of these purge modes will be adjustable. Should the supply fan not match it commanded state, an alarm will be generated at the building operation computer.

.3 Damper Control

.1 The outside air damper will close only when the fan is shut down. The damper will open first and the end switch on the damper will close before the fan is started.

.4 Pressure Control

.1 The duct static pressure sensor varies the fan inlet vanes to maintain the static pressure to set point. The static pressure set point is determined by the air balancing contractor so that all VAV boxes are satisfied in all conditions.

.5 Temperature Control

.1 The discharge air temperature is adjusted by an average of 6 space temperature signals to give a reading of the building heating or cooling loads. Three way mixing valve in the heat recovery loop will modulate to extract heat from the exhaust air stream to maintain the supply temperature to set point. The heat recovery pump will run whenever the outdoor air temperature is. below 18°C. If heat recovery is Insufficient to maintain the supply temperature up to set point, the three way heating valve will modulate to provide additional heat. Heating coil pump P-311 will run whenever the outdoor air temperature is below 18°C and the heating valve is commanded open, or if the outdoor air temperature is below 6°C regardless of the valve command. Should cooling be required instead of heating, the chilled water three way mixing valve will modulate to provide cooling to satisfy the supply set point.

.6 Safeties

.1 The low temperature thermostat will stop the system should the air temperature off the heating coil drop below 4°C. The fan will shut down, the damper will close, and the heating valve will open to 100% heating. A manual reset will be required at the thermostat to restart the system.

.7 Interlocks

.1 Exhaust fans EF-301, EF-302, EF-303, EF-304 and EF-385 are interlocked to operate in conjunction with this supply fan by software interlocks. All air terminals in the space will close when the system is off. An EP valve will de energize, causing the air supplied to these normally closed boxes to be cut off.

.8 Alarms

.1 An alarm will be generated at the building operation computer for the following:

.1 Supply fan or outdoor air damper not matching its commanded state.

.2 Temperature low limit tripped.

.2 New AHU-301 Sequence of Controls

.1 General

.1 The new AHU-301 sequence of controls will be identical to existing AHU-301 sequence of controls above except for the following changes:

.2 Pressure Control

.1 The duct static pressure sensor will vary the fan VSD to set point.

.3 Temperature Control

.1 The heat recovery system is deleted. The heating face and bypass dampers will modulate to maintain set discharge air

temperature. A new DDC discharge air temperature controller and sensor will be provided. A new 3 way hot and chilled water control valve will be provided.

.4 Filter Pressure Drop

.1 Filter differential switches across HEPA filter section and V8 filter section shall send an alarm to DDC system upon excessive pressure drop.

.5 Provide monitoring of the following:

.1 Outdoor air temperature
.2 Return air temperature
.3 Supply air temperature
.4 Supply fan status
.5 Space air temperature
.6 Space relative humidity
.7 Freezestat alarm
.8 VFD status
.9 Heating coil discharge temperature
.10 Cooling coil discharge temperature
.11 Space pressure
.12 Discharge air relative humidity
.13 Supply air quantity
.14 Outdoor air humidity
.15 HEPA filter pressure drop
.16 HEPA filter alarm
.17 V8 filter pressure drop
.18 V8 filter alarm
.19 Space pressure alarm
.20 The above monitoring and control points shall be provided with the AHU-301 integral controls and monitored through building DDC Controls. Any control devices and wiring external to the AHU-301 such as space humidity sensor, etc. shall be provided by the EMCS contractor.

.6 General

.1 The new AHU-301 packaged integral BacNet controls shall be monitored by the existing DDC Control system. Control contractor shall provide all devices and / or programming for required interface.

.3 Room 222 Humidity

.1 Room humidity sensor will control electric humidifier H-301 integral control.

.2 DDC will monitor room humidity level and generate an alarm if room humidity is out of range (40%-70%).

.4 Pump 301A Pressure Control

.1 DI water supply pump P-301A will maintain a constant water pressure as controlled by the integral controller.

.2 Loss of pressure will generate an alarm at DDC computer.

.5 Programming

.1 The existing programming and schematics will be modified to incorporate all new changes.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 Related Sections & Summary

.1 The General Conditions, Supplements and Amendments shall govern this Section (read in conjunction with Instructions to Tenderers / Bidders). This section covers items common to all Electrical sections and is intended only to supplement the requirements of Division 01.

.2 Reference to “Electrical Divisions” shall mean all related Electrical Sections and components including Divisions 26, 27, 28, and 33 in the Master Format Specifications.

.3 Reference to “Mechanical Divisions” shall mean all related Mechanical Sections and components including Divisions 23 and 25 in the Master Format Specifications.

.4 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.

.5 Provide materials, equipment and plant, of specified design, performance and quality; and, current models with published certified ratings for which replacement parts are readily available. Provide project management and on-site supervision to undertake administration, meet schedules, ensure timely performance, ensure coordination, establishing orderly completion and the delivery of a fully commissioned installation.

.6 The most stringent requirements of this and other electrical sections shall govern.

.7 All work shall be in accordance with the PROJECT Drawings and Specifications and their intents, complete with all necessary components, including those not normally shown or specified, but required for a complete installation.

.8 Provide seismic restraints for all required equipment, piping and ductwork.

.9 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories

1.2 References

.1 Install in accordance with CSA C22.1-2015 except where specified otherwise.

.2 Comply with CSA Electrical Bulletins and local by laws.

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-C235-83.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 Scope of Work

.1 Contractor shall supply, install, commission and provide warranty for a complete and fully documented electrical system as per contract drawings and specified herein. The Work includes all hardware, and services necessary to provide fully functional, coordinated electrical system. Refer to Division 1 for hours of work.

.2 Component subsystems of the electrical system will include, but are not limited to the following:

.1 Provide electrical power system including distribution.
.2 Provide receptacles and direct connections for all equipment.
.3 Provide power feeders to all mechanical equipment.
.4 Provide all required motor starters and control wiring associated.
.5 Provide complete raceway for power.

.3 Provide grounding/bonding equipment as per CEC or as indicated in the contract drawings and specifications.

.4 Provide fire stopping as per Division 01 Section 07 84 00.

.5 Perform commissioning as per Division 01 Section 01 91 00.

.6 As-built drawings and maintenance manuals.

.7 Seismic restraint for all electrical equipment and installations.

1.6 Submittals

.1 Submittals to be in accordance with Division 01.

.2 Submit shop drawings, product data and samples in accordance with Division 01. The submission shall be reviewed, signed and processed as described in Division 01.

.3 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.

.4 Where applicable, include wiring, line and schematic diagrams. Include wiring drawings or diagrams showing interconnection with work of other Sections.

.5 Content

.1 Shop drawings submitted in accordance with Division 01.

.2 Data shall be specific and technical.

.3 Identify each piece of equipment.

.4 Information shall include all scheduled data.

.5 Advertising literature will be rejected.

.6 The project and equipment designations shall be identified on each document.

.7 Information shall be given in S.I. units

.8 The shop drawings/product data shall include:

.1 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with all equipment weight and mounting point loads.

.2 Mounting arrangements.

.3 Detailed drawings of bases, supports and anchor bolts.

.4 Control explanation and internal wiring diagrams for packaged equipment.

.5 A written description of control sequences relating to the schematic diagrams.

.6 Format

.1 Black line prints 216 mm x 280 mm [8-1/2" x 11"] or 280 mm x 430 mm [11" x 17"].

.2 Larger drawings may be submitted on reproducible single sheet media (ie not bound) with space for stamps and signatures - master set plus one working copy.

.3 Bill of Quantities for related components, identified by model number, listed on the front cover with item identification numbers.

.7 No. of copies

.1 Provide number of copies indicated in Section Division 01 with a minimum of 2 copies to be retained by the Consultant.

.8 Coordination

.1 Where electrical equipment requires support or backing by other trades or mechanical connections, the shop drawings shall also be circulated through the other "services" contractor(s) prior to submission to the Consultant.

.9 Keep one [1] copy of shop drawings and product data, on site, available for reference.

.10 Quality Control: in accordance with Division 01 - Quality Control

.1 Provide CSA certified equipment and material. Where CSA certified equipment and/or material is not available, submit such equipment and/or material to the authority having jurisdiction for special approval before delivery to site.

.2 Submit test results of installed electrical systems and instrumentation.

.3 Submit, upon completion of Work, the electrical “load balance” report.

.11 Permits and Fees:

.1 Submit to Electrical Inspection Department, Local Fire Authorities and Supply Authority the necessary number of drawings and specifications for examination

and approval prior to commencement of work. Obtain all required permits and pay all fees.

.2 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work, furnish final unconditional certificates of approval by the inspecting authorities.

1.7 Quality Assurance

.1 Quality Assurance: in accordance with Division 01 - Quality Control

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians in accordance with authorities having jurisdiction.

.1 Employees registered in 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: in accordance with Division 01 - Construction Schedule

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Division 01 - Health and Safety Requirements.

1.8 Delivery, Storage and Handling

.1 Material Delivery Schedule: provide Consultant with schedule within 4 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and/or recycling in accordance with Division 01 Construction Waste Management and Disposal.

1.9 System Start-Up

.1 Refer to Division 01, and as follows.

.2 Instruct the Consultant and operating personnel in the operation, care and maintenance of equipment.

.3 Arrange and pay for services of manufacturer's factory service Engineer to supervise start-up of installation, check, adjust, balance and calibrate components.

.4 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.

1.10 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.

1.11 Waste Management and Disposal

.1 Avoid using landfill waste disposal procedures when recycling facilities are available.

.2 Place materials defined as hazardous or toxic waste in designated containers.

1.12 Drawings and Measurements

.1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work and are not detailed installation drawings. Do not scale the drawings. Obtain accurate dimensions from site.

.2 Take field measurements, where equipment and material dimensions are dependent upon building dimensions.

1.13 Project Coordination

.1 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra cost to the Owner, without the Consultant's written approval.

.2 The drawings indicate the general location and route to be followed by the electrical services. Where details are not shown on the drawings or only shown diagrammatically, the services shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All services in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All electrical services shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.

.3 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary, produce interference/coordination drawings showing exact locations of electrical systems or equipment within service areas, shafts and the ceiling space. Distribute copies of the final interference/coordination drawings to the Consultant and all affected parties.

.4 Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Consultant of space problems before installing any material or equipment. Demonstrate to the Consultant on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.14 Sprinkler Proof Requirements

.1 All equipment and wiring systems in sprinklered rooms shall be sprinklerproof.

.2 In sprinklered rooms where electrical equipment is installed surface mounted, electrical equipment contained in these rooms to be protected by non-combustible driphoods, shields, and gasketed doors as applicable to inhibit water ingress into electrical equipment. Exposed conduits connected to equipment to utilize watertight connectors.

1.15 Equipment Restraint

.1 Related Section: 26 05 25 Seismic Restraint.

.2 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

1.16 Warranty

.1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the Division 01.

.2 Take note of any extended warranties specified.

.3 Furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period of one (1) year from the date of substantial performance.

.4 Promptly investigate any electrical or control malfunction, and repair or replace all such defective work, and all other damages thereby which becomes defective during the time of the warranty.

1.17 Tender Inquiries

.1 All contractor queries during the tender period shall be made in writing to the Consultant. Contractor queries will be collected and suitable addenda will be issued for clarification. No verbal information will be considered valid or issued by the Consultant's office during tender. All tender queries may be faxed, mailed or couriered to the Consultant's office. No telephone questions will be answered.

1.18 Examination

.1 Visit the site before preparing the tender and examine all existing conditions are beneficent to the contractor. No extra cost will be considered for any misunderstanding of work to be done resulting from not visiting the site.

.2 Examine the documents for details of work included. Obtain a written clarification in the event of conflict within the specification, between the specification and the drawing, or in the drawing. Obtain written clarification from the Consultant if work affecting the installation is not clear. Where this is not done in advance, allow in the tender sum for providing the more costly alternative.

1.19 Responsibilities

.1 Ensure that equipment does not transmit noise and/or vibration to other parts of the building, as a result of poor installation practice.

.2 Where the Contract Documents do not contain sufficient information for the proper selection of equipment for bidding, notify the Consultant during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the Contractor of responsibility to provide the intended equipment.

.3 Protect equipment and material from the weather, moisture, dust and physical damage.

.4 Cover equipment openings and open ends of conduit, piping and pullboxes as work progresses. Failure to do so will result in the Trade being required to adequately clean or replace materials and equipment at no extra cost to the Owner.

.5 Protect all existing services encountered. Obtain instructions from the Consultant when existing services require relocation or modification.

.6 Refinish damaged or marred factory finish to factory finish.

.7 The specifications and drawings form an integral part of the Contract Documents. Neither the drawings nor the specifications shall be used alone. Work omitted from the drawings but mentioned or reasonably implied in the specifications, vice versa, shall be considered as properly and sufficiently specified and shall be provided. Misinterpretation of any requirement of either plans or specifications shall not relieve this Contractor of the responsibility of properly completing his trade to the approval of the Consultant.

1.20 Equipment List

.1 Submit a completed Equipment List, showing the make of equipment and material included in the Tender, including the names of the subtrades, 10 days after the award of the Contract.

.2 The equipment list shall be a full list of materials or systems intended for installation.

1.21 Progress Claim and Change order Breakdowns

.1 Ten (10) days after the award of contract, submit detailed price breakdowns for each division.

.2 Progress claims will not be certified nor payment made beyond 90% of the overall Electrical contract until commissioning and verification of the systems are complete. This procedure is to allow for any necessary deficiency holdbacks on items which do not become apparent until the systems are commissioned.

1.22 Project Close-Out Requirements

.1 Refer to detailed specifications in each section for detailed requirements. Provide the following list of required substantial completion submissions.

.1 Seismic engineer report and schedules.
.2 Final electrical inspector certificate.
.3 Record drawings.
.4 Operating and maintenance manual.
.5 Contractors letter of guarantee.
.6 Complete Demonstration of systems to staff.

.2 Record drawings to be submitted to the Consultant and all life safety systems must be operational, verified and tested and demonstrated to Consultant prior to issuance of Schedule C.

1.23 Substantial Performance Requirements

.1 Before the Consultant is requested to make an inspection for substantial performance of the work:

.1 Commission all systems and prove out all components, interlocks and safety devices.
.2 Submit a letter certifying that all work is complete for the intended use, operational, clean and all required submissions have been completed.
.3 A complete list of incomplete or deficient items shall be provided. If, in the opinion of the Consultant, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.

.2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:

.1 All reported deficiencies have been corrected.
.2 Operating and Maintenance Manuals completed.
.3 "As Built" Record Drawing ready for review.
.4 Systems Commissioning has been completed and has been verified by Consultant.
.5 All demonstrations to the owner have been completed.
.6 All documents required have been submitted.

.3 Consultant’s Letters of Assurance will not be issued until the following requirements have been met:

.1 All items listed in .1 above have been completed or addressed.

.2 Certificate of Penetrations through separations have been sealed with certified fire stopping material.

.3 Territory or City Electrical Inspection - Certificate of inspection.

.4 Seismic Engineers letter of Assurance and final inspection report.

.5 Certificate of Substantial Performance.

.6 Signed off copy of Consultant s final inspection report.

Part 2 PRODUCTS

2.1 Sustainable Requirements

.1 Materials and products in accordance with Division 01 - Sustainable Requirements: Construction

.2 Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

2.2 Materials and Equipment

.1 Provide materials and equipment in accordance with Division 01 and as follows.

.2 Material and equipment to be CSA certified. Where CSA certified material or equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval.

.3 Where equipment or materials are specified by technical description only, they are to be of the best commercial quality available for the intended purpose.

.4 Factory assemble control panels and component assemblies.

2.3 Electric Motors, Equipment and Controls

.1 Provide all power and electrical system related control wiring, conduit, wire, fittings, disconnect switches, motor starters, for all mechanical equipment unless otherwise specified.

.2 Ground all motors to conduit system with separate grounding conductor in flexible conduit or bonding conductor in the flexible conduit.

.3 Connections shall be made with watertight flexible conduit with watertight connectors.

.4 Control wiring and conduit standards are specified in the Electrical Divisions. Refer to Mechanical Divisions for scope of work and particular details.

2.4 Warning Signs

.1 Provide warning signs, as specified or to meet requirements of Inspection Department, Consultant and Architect.

.2 Use decal signs, minimum 175 x 250 mm [7” x 10”] size

2.5 Wiring Terminations

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

2.6 Equipment Identification

.1 Identify all electrical equipment including but not limited to starters, disconnects, remote ballasts and controls with nameplates and labels as follows:

.2 Nameplates:

.1 Electrical Equipment:

COMPONENT	LABEL TYPE	INFORMATION
Main distribution centre	A	Year installed and name of facility Name of Electrical Engineer and Electrical Contractor
Main Breaker	A	Voltage, phase, amps
Sub-distribution panel	A	Name of panels it is feeding (i.e. Panel A, Panel B)
Panelboards	B	Panel designation (i.e. Panel A, Panel B)
Terminal Cabinet	B	System and Voltage
Disconnect switches	B	Indicate equipment controlled and voltage
Starters/contactors	B	Indicate equipment controlled and voltage
Motor control centre	B	Indicate equipment controlled and voltage
Transformer	B	Transformer designation Circuit and Panel designation
Junction boxes, pull boxes	D	Circuit and panel designation
On/Off switches	C	If it is not obvious, then indicate area being served
Fire Alarm Devices (i.e. pull stations, bell, smoke detector, end-of –line)	C	Zone number and device number in that zone (i.e. Zone 1-#3, Zone 10-#7)
Receptacles	C	Circuit/panel designation
Special receptacles	C	Circuit/panel designation and voltage, phase, amps

.2 Label Type:

	LETTER HEIGHT	TYPE	COLOUR
Label Type A	9.5 mm	Lamacoid	White lettering/black backgroung

Label Type B	6.0 mm	Lamacoid	White lettering/black backgroung
Label Type C	3.0 mm	Lamacoid	White lettering/black backgroung
Label Type D	3.0 mm	Adhesive label	As specified

.3 Adhesive Labels:

.1 Good quality vinyl, self-laminating label as T & B E-Z Code WSL, Dymo Letratag or Brother P-Touch equivalent printable markers. Embossed Dymo or any labels with edges and corners that are prone to lift will be rejected.

.4 Provide plastic covered panel directory with circuits and areas served print in, and mounted on inside of door. Directory shall conform to Record Drawings.

2.7 Wiring Identification

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.8 Conduit, Cable and Pullbox Identification

.1 All junction boxes, pull boxes and their cover shall be painted according to the colour coding schedule.

.2 All entries to panels, junction boxes, pull boxes and device boxes.

.3 Code with 25 mm plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor and at 15 m intervals.

.4 Colour coding to be as follows unless otherwise specified:

COMPONENT	RACEWAY AND JUNCTION BOXES	RECEPTACLES AND OTHER
Normal 120/208, 240 volt	Gray	White
Normal 347/600 volt	Sand	White
Emergency 120/208, 240 volt	Green with red bands	Red
Emergency 347/600 volt	Sand with red bands	n/a
Fire Alarm	Red	Strobe (red)
Low voltage		
-switching/controls	Black	
-emergency/exit lighting	Black with red bands	

-security	Black with blue bands	Strobe (blue)
-mechanical alarms	Black with yellow bands	Strobe (amber)

2.9 Finishes

.1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside and at least two coats of finish enamel.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original finish.

.3 Clean and prime paint exposed hangers, racks, fastenings to prevent rusting. Finish painting shall be provided by Division 09.

2.10 Access Panels (Doors)

.1 Unless otherwise noted, access doors shall be minimum: 450mmx450mm [18"x18"] for body entry; 300mmx300mm [12”x 12”] for hand entry.

.2 Access doors in fire separations of 3/4 hour rating, and higher, and firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, keyed and self closing.

.3 Minimum Requirements:

.1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.

.2 Plaster or wet wall construction: 14 gauge bonderized steel flush with wall or ceiling type with concealed flange.

.3 Masonry or drywall construction: 16 gauge for 400 mm [16"] x 400 mm [16"] and smaller, 14 gauge for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange.

.4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 gauge stainless steel flush with wall or ceiling type with concealed flange.

.5 Acoustical tile ceiling and similar block materials: 14 gauge bonderized steel recessed ceiling type.

.6 Feature wall construction: Recessed wall type that is selected to complement and conform with the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.

.7 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label. (i.e. Acudor Fire Rated FW-5050 or FB-5060).

2.11 Fastening to Building Structure

.1 General:

.1 Do not use inserts in base material with a compressive strength less than 13.79 MPa [2000 psi].

.2 All inserts supporting conduit racks shall have a factor of safety of 5. All other inserts shall have a factor of safety of 4.

.2 Types:

.1 Cast-in-place type:

.1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.

.2 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 200 mm [8"] pipe size.

.3 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 200 mm [8"] pipe size.

.2 Drilled, mechanical expansion type:

.1 Hilti HSL or UCAN LHL heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa [2840 psi].

.2 Hilti Kwik-Bolt or UCAN WED stud anchor for concrete. (Do not use in seismic restraint applications).

.3 Hilti HDI or UCAN IPA drop-in anchor for concrete.

.4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.

.5 Hilti ZBP or UCAN Zamac pin bolt (light duty) for concrete and masonry.

.3 Drilled, adhesive type:

.1 Hilti HVA or UCAN Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.

.2 Hilti HY150 consisting of anchor rod with a 2 part adhesive system.

.3 For use in concrete housekeeping bases (in vertical downward position) where the distance to the edge of the concrete base could cause weakness if a mechanical expansion type anchor were used.

.4 Rod assemblies shall extend a minimum of 50 mm [2"] into the concrete slab below the housekeeping bases.

.3 Note:

.1 Before any floor drilling, confirm location of under floor heating equipment with mechanical Division.

.2 All drilling for inserts shall be performed using the appropriate tool specifically designed for the particular insert. The diameter and depth of each drilled hole shall be to the exact dimensions as specified by the insert manufacturer.

.3 Refer to manufacturer's recommendations for tightening torques to be applied to inserts.

.4 Where specifically called for, drills shall include a dust vacuum system, Hilti SAV Dust Vacuum System.

2.12 Equipment Supports

.1 Provide stands and supports for equipment and materials supplied.

.2 Lay out concrete bases and curbs required under Electrical Divisions. Coordinate with Concrete Divisions.

.3 Concrete bases shall be a minimum of 100 mm [4"] thick, or as noted and shall project at least 150 mm [6"] outside the equipment base, unless otherwise directed. Bases and curbs shall be keyed to the floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases at 45 degrees.

.4 Equipment with bedplates shall have metal wedges placed under the edges of the bedplates to raise them 25mm [1"] above the base after levelling. The wedges shall be left permanently in place. Fill the space between the bedplate and the base with non-shrink grout - Embeco or In-Pakt.

.5 Construct equipment supports of structural steel. Securely brace. Employ only welded construction. Bolt mounting plates to the structure.

.6 Support ceiling hung equipment with rod hangers and/or structural steel.

2.13 Miscellaneous Metal

.1 Be responsible for all miscellaneous steel work relative to Electrical Divisions of the Specifications, including but not limited to:

.1 Support of equipment.

.2 Hanging, support, anchoring, guiding and relative work as it applies to wiring raceways and electrical equipment.

.3 Earthquake restraint devices - refer also to “Seismic Restraint” sections

.4 Bridle rings - secure to structure or steel supports.

.2 All steel work shall be prime and undercoat painted ready for finish under the related Division.

2.14 Operation and Maintenance Data

.1 Provide operation and maintenance data for incorporation into maintenance manual specified in Division 01 and as follows.

.2 Include in operations and maintenance data:

.1 Details of design elements, construction features, component function and maintenance requirements, to permit effective operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.

.2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.

.3 Wiring and schematic diagrams.

.4 Names and addresses of local suppliers for items included in maintenance manuals.

.3 Include in the manual the following major sections:

.1 Title page (in plastic cover).

.2 Comprehensive description of the operation of the systems, including the function of each item of equipment within the system.

.3 Detailed instructions for the normal maintenance of all systems and equipment installed including procedures and frequency of operational checks and service and trouble shooting instructions.

.4 Local source of supply for each item of equipment.

.5 Wiring and control diagrams.

.6 Spare parts list.

.7 Copies of guarantees and certificates.

.8 Manufacturer's maintenance brochures and shop drawings.

.4 The manual information shall be bound in a three “D-ring” hard back reinforced vinyl covered ("bar lock" post type where more than 50mm [2”] rings required) binder c/w index tab separators to divide the different sections. The binder cover shall be black with white lettering. Printing of the binder cover shall be completed before the binder is manufactured and the wording shall be approved by the Consultant before printing.

.5 Submit a draft copy to the Consultant for approval thirty (30) days prior to start up of the systems and equipment.

.6 Submit three (3) copies in the final approved form.

.7 Submit 3 CDs containing all record as-build drawings and maintenance manual in pdf format.

2.15 Project Record Drawings

.1 Provide project record documents as specified in Division 01 as further called for in this Division.

.2 During the construction period, keep on Site a clean set of drawings marked up to reflect the "As-Built" state, for examination by the Consultant on a regular basis. Include elevations and detailed locations of buried services, empty conduit systems and junction and pull boxes.

Part 3 Execution

3.1 Installation

.1 Do complete installation in accordance with CSA C22.1 2015 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

.3 Comply with CSA Electrical Bulletins and local by laws.

3.2 Nameplates and Labels

.1 Ensure manufacturers nameplates and CSA labels to be visible and legible after equipment is installed.

3.3 Conduit and Cable Installation

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit and protruding 50 mm [2”].

.2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

.3 Install roof jacks where conduit and cables penetrate roofs. Apply sealant after installation.

.4 All cables and conduits to be installed concealed in finished areas.

3.4 Location of Outlets

.1 Refer to Architectural detail drawings for outlet locations. Confirm with Department Representative before rough-in.

.2 Do not install outlets back-to-back or in the same stud space in wall; allow minimum 400mm [16”] horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm [10”- 0”] and information is given before installation.

.4 Locate light switches on strike side of doors unless otherwise indicated.

.5 Locate light switches on latch side of doors.

.6 Locate disconnect devices in mechanical and elevator machine rooms 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 indicated verify before proceeding with installation. Confirm the height of devices in handicapped facilities before installation.

.3 Refer to detail on architectural drawings.

.4 In the absence of a drawing detail or drawing note, use the following:

Device	Height		Comment
Local switches	1200	[48”]	
Wall receptacles/data	300	[12”]	General
Wall receptacles/data	175	[7”]	Above top of counters or counter splash backs – coordinate with Architectural detail
Wall receptacles/data	1400	[56”]	In mechanical rooms
Panelboards			Panelboards: as required by Code or as indicated.

Wall mounted telephone	1500	[60”]	
Fire alarm stations	1200	[48”]	As required by ULC S524.
Fire alarm bells/audio/visual	2300	[90”]	ULC S524 requires not less than 1800mm. In any event not closer than 50mm to the ceiling
End of line resistors	1800	[72”]	
Television outlets			As receptacles –coordinate with equipment location
Wall mounted speakers & clocks	2100	[84”]	Coordinate with equipment location
Door bell pushbuttons	1200	[48”]	Coordinate with location
Emergency Lighting (wall mounted)			150mm below ceiling or 2300mm max.

.5 Confirm mounting height with Department Representative before rough-in.

3.6 Delivery and Storage

.1 Store all electrical equipment and devices other than conduits, fittings, boxes, and ducts in a heated and ventilated space, and protect from construction damage. Include in the tender price all costs related to such storage.

.2 Conduits, fittings, boxes, and ducts may be stored outside if properly protected against the weather.

.3 Ship and store floor mounted equipment in upright position.

.4 Ship equipment in adequate containers to assure it arrives undamaged at the site.

.5 Keep equipment doors locked. Protect equipment from damage and dust.

.6 Block moving parts when necessary to prevent damage during movement and shipment of equipment.

.7 Remove from the site, and replace with new, all materials showing evidence of damage or rust.

3.7 Co-ordination of Protective Devices

.1 Coordinate and pay for all tests specified herein including further tests as required by authorities having jurisdiction.

.2 All testing shall be performed after each system installation has been completed. Prior to commissioning, all motors, MCCs, transformers and switchgear shall be meggered for insulation integrity and the results recorded prior to the systems being put into operation.

.3 Perform the testing, adjusting, and balancing only when conditions are commensurate with actual operating conditions for the given system.

.4 Advise the Consultant 48 hours in advance of each test. Carry out tests in the presence of Consultant.

.5 Submit detailed printed test reports in duplicate to the Consultant within 7 days after the completion of each test. Include all test reports in the Maintenance Manuals. Each test shall clearly indicated, in a line-by-line format, that the components (not as a group) have been tested, test results, and whether test results are within acceptable limits. Each test report shall be accompanied by a front cover sheet briefly outlining what the test report is for and clearly summarizing all items that have failed the tests. The cover sheet shall indicate names of individuals who conducted the tests and their signatures.

3.8 System Coordination Study

.1 Provide with shop drawings a family of neatly drawn coordination curves on standard EEI-NEMA sheets, showing service feeder relays (including ground fault), together with manufacturer's proposed tripping characteristics for main service and feeder overcurrent relays, transformer, thermal damage curves. The curves shall also include ground fault coordination. For each coordination curve, attach a separate blank page with a neatly drawn single-line diagram with cross-reference between protecting devices and their corresponding coordination curves. The coordination study shall include for selective tripping such that downstream loads are isolated at the point as far downstream in the distribution system as possible. The Consultant reserves the right to make changes in the rating and setting of the protection devices without change to the tender price to ensure a properly coordinated "selective" protection system.

.2 The approved coordination study will be the basis for the verification testing of all other applicable equipment.

.3 Ensure circuit protective devices such as overcurrent trips, relays, and fuses are installed to required values and settings and further adjusted in accordance with the approved coordination study.

.4 Coordination study shall be signed and sealed by a registered Yukon Professional Engineer.

3.9 Field Quality Control

.1 Load and Balance:

.1 Measure voltage and phase & neutral currents 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 Conduct and pay for the following tests:

.1 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.2 Systems: fire alarm system, communications systems.

.3 Main ground resistance (at all grounding locations).

.3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.4 Reports:

.1 Provide written reports in a timely manner upon completion of the testing and load balance. Indicate test hour and date.

3.10 Demonstration

.1 Demonstrate to and instruct the Owner's representative on operating and maintenance procedures for all electrical systems using the assistance of specialist sub-trades and manufacturer's representatives for instruction and include all costs in the tender. Systems to be demonstrated shall include, but not be limited to, the following:

.1 Routing and installation of major feeders, duct banks and manholes, grounding and cable trays.

.2 Arrange an acceptable time with the Owner and the Consultant and submit a program of instruction and demonstration for the Consultant's approval. Assume that the Owner's representative is not familiar with any of the special equipment and/or systems installed.

.3 Submit to the Consultant, at the time of Substantial Performance inspection, a complete list of systems stating for each system:

.1 Date instructions were given to the Owner's staff.

.2 Duration of instruction.

.3 Name of persons instructed.

.4 Other parties present (manufacturer's representative, Consultant, etc.).

.5 Signature of the Owner's staff stating that they properly understood the system installation, operation, and maintenance requirements and identifying any systems or equipment which were not demonstrated to their satisfaction and which must be re-demonstrated.

3.11 Cleaning

.1 Do final cleaning in accordance with Division 01.

.2 At time of final cleaning, clean lighting reflectors, lenses and other lighting surfaces that have been exposed to construction dust and dirt.

.3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.4 Clean and prime paint exposed non-galvanised hangers, racks, fastenings to prevent rusting. Coordinate finish painting with Division 09.

3.12 Workmanship

.1 Workmanship shall be in accordance with well established practice and standards accepted and recognized by the Consultant and the Trade.

.2 The Consultant shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish and appearance.

.3 Employ only tradesmen holding valid Provincial Trade Qualification Certificates. Tradesmen shall perform only work that their certificate permits. Certificates shall be available for inspection by the Consultant.

3.13 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Division 01 - Construction Waste Management and Disposal.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

3.14 Protection of Work

.1 Protect equipment and materials, stored or in place, from the weather, moisture, dust and physical damage.

.2 Mask machined surfaces. Secure covers over equipment openings and open ends of equipment and conduit, as the installation work progresses.

.3 Equipment having operating parts, bearings or machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.

.4 Refinish damaged or marred factory finish.

3.15 Protection Electrical Equipment

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts, e.g. "LIVE 120 VOLTS".

.3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

3.16 Concealment

.1 Conceal wiring and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.

.2 Do not install wiring and conduit on outside walls or on roofs unless specifically directed.

3.17 Service Penetrations in Rated Fire Separations

.1 All cabling, wiring, conduits, cable trays, etc. passing through rated fire separations shall be smoke and fire stopped to a ULC or cUL tested assembly system, in accordance with CAN4-S115-11, that meets the requirements of the Building code in effect.

.2 The scope includes new services which pass through existing rated separations and also all existing services which pass through a new rated separation or existing separations whose rating has been upgraded.

.3 Fire resistance rating of installed firestopping assembly shall not be less than fire resistance rating of surrounding assembly indicated on Architectural drawings. Where this is not indicated assume a minimum of one hour for walls and two hours for floors.

.4 Install firestopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions. The Applicator shall be approved, licensed and supervised by the manufacturer in the installation of firestopping and are to follow the requirements of a rated system as detailed above.

.5 Contractors are expected to submit system information detailing firestopping product, backing, penetration, penetrated assembly, Fire (F) and Temperature (T) rating, and ULC or cUL system number.

.6 Provide fire stopping material and system information in the maintenance manuals and via labels at major penetrations that are likely to be re-penetrated.

.7 All penetrations are to be firestopped using EZ Path System (Specified Technologies Inc - STI) only.

.8 Allow openings for 100% capacity of raceway or 200% capacity of J-hooks.

.9 Provide split systems where existing cables are involved.

.10 Submit a letter certifying that all work is complete and in accordance with this specification. Electrical Form EF130 in Section 26 06 02 should be used for this purpose.

3.18 Service Penetrations in Non-Rated Separations

.1 Provide metal sleeves for all cabling, wiring, conduits, cable trays, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with caulking or silicon sealant to prevent the passage of smoke and/or transmission of sound.

3.19 Conduit Sleeves

.1 Provide conduit sleeves for all conduit and wiring passing through rated and non-rated walls and floors. Sleeves shall be concentric with conduit or wiring.

.2 Except as otherwise noted conduit sleeves are not required for holes formed or cored in interior concrete walls or floors.

.3 Conduit sleeves shall extend 50 mm [2"] above floors in unfinished areas and wet areas and 6 mm [1/4"] above floors in finished areas.

.4 Conduit sleeves shall extend 25 mm [1"] on each side of walls in unfinished areas and 6 mm [1/4"] in finished areas.

.5 Conduit sleeves shall extend 25mm [1"] beyond exterior face of building. Caulk with flexible caulking compound.

.6 Sleeve Size: 12 mm [1/2"] clearance all around, between sleeve and conduit or wiring.

.7 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.

.8 Packing of Sleeves:

.1 Where sleeves pass through foundation walls and perimeter walls the space between sleeve and conduit shall be caulked with waterproof fire retardant non-hardening mastic.

.2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.20 Accessibility and Access Panels

.1 Install all equipment, controls and junction boxes so as to be readily accessible for future modification, adjustment, operation and maintenance as appropriate.

.2 Provide access panels where required in building surfaces. Do not locate access panels in panelled or special finish walls, without prior approval of the Consultant.

.3 Access panels in U.L.C. fire separations and fire walls shall have a compatible fire rating and U.L.C. label. Acquire approval in writing from the local fire authority if required.

.4 Access panels shall be painted with a primer coat if applicable and then with a finish coat, colour and type to the Consultant's approval.

.5 Locate equipment and junction boxes in service areas wherever possible.

3.21 Equipment Installation

.1 Provide means of access for servicing equipment.

.2 CSA identification and equipment labels to be clearly visible after installation.

3.22 Cutting, Patching, Digging, Canning, Coring & Concrete

.1 Lay out all cutting, patching, digging, canning and coring required to accommodate the electrical services. Coordinate with other Divisions. The performance of actual cutting, patching, digging, canning and coring is specified under other Divisions.

.2 Be responsible for correct location and sizing of all openings required under Electrical Divisions, including piped sleeves.

.3 Openings through structural members of the building shall not be made without the approval of the Consultant.

.4 Openings in Concrete:

.1 Be responsible for the layout of all openings in concrete, where openings are not left ready under previous contract.

.2 All openings shall be core drilled or diamond saw cut.

.3 Refer to structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls.

.4 Refer to structural drawings for locations of steel reinforcing.

.5 Be responsible for repairing any damage to steel reinforcing.

.5 Openings in building surfaces other than concrete:

.1 Lay out all openings required.

.6 Poured concrete for duct encasements, pole bases, transformer pads and housekeeping pads shall be provided by other Divisions, coordinated and supervised by the Electrical Divisions.

.7 Precast concrete items such as transformer pad bases and light pole bases to be provided and installed by the Electrical Divisions unless otherwise specified.

.8 Excavation and backfilling will be provided by other Divisions. This division to superintend the work and provide all layouts and parameters.

3.23 Painting

.1 Clean exposed bare metal surfaces supplied under the Electrical Divisions removing all dirt, dust, grease and millscale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.

.2 Paint all hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer, as they are installed.

.3 Repaint all marred factory finished equipment supplied under the Electrical Divisions, to match the original factory finish.

.4 Coordinate with Division 09.

.5 Finish painting of all equipment and materials, supplied under the Electrical Divisions, installed in Electrical Rooms of the building or exposed outside the building, is included under Division 09 of the Specification.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Refer to specialty “Communication” Sections for particular wiring systems and types. e.g. Fire Alarm, Security and Voice/Data

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 00 - Common Work Results - Electrical

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.2 CSA C22.1-2015

.3 National Electrical Manufacturers Association (NEMA)

1.4 PRODUCT DATA

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

1.5 TERMS OF REFERENCE

.1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.

.2 Armoured (BX) cable may be utilized for motor connection and recessed tee bar luminaire drops from ceiling mounted outlet boxes. "Tite Bite" connectors and their counterparts of other manufacturers shall not be used. Cable from luminaire to luminaire is not permitted. Allow nominally 900mm [3’] extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space. From any junction box, a maximum 2.5 meter of cable can be used for motor connection and 5 meter for luminaries. Separate ground conductor is required for ‘BX’ cable.

.3 Aluminium conductors are not permitted.

.4 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having a PVC jacket with FT-4 flame spread rating.

.5 Provide all control wiring except HVAC controls as specified in Mechanical Divisions.

.6 Refer to Equipment Schedule(s) for detailed responsibilities.

.7 Non-metallic sheathed wiring is not to be used on this project.

Part 2 Products

2.1 WIRING & CABLES – GENERAL

.1 Conductors: stranded for 12 AWG and larger. Minimum size #12 AWG.

.2 Insulation to be 600 volt RW90XLPE (X link) for the general building wiring in conduit.

.3 Main feeders to be conduit and insulated copper wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.

.4 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and condulet fittings. Conductors not to be painted.

2.2 ARMOURED CABLE (BX)

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90 600 V rated.

.3 Armour: interlocking type fabricated from galvanized steel.

2.3 TECK CABLE

.1 Conductors:

.1 Grounding conductor: copper

.2 Circuit conductors: copper, size as indicated.

.2 Insulation: Chemically cross-linked thermosetting polyethylene, type RW90, rated 600 V.

.3 Inner jacket: polyvinyl chloride material.

.4 Armour: interlocking aluminum.

.5 Overall covering: polyvinyl chlorid material.

.6 Connectors: Watertight, approved for Teck cable installation.

2.4 LOW VOLTAGE CONTROL CABLES

.1 Type LVT: soft annealed copper conductors, with thermoplastic insulation, outer covering of thermoplastic jacket. Minimum size #18 AWG.

.2 Unless otherwise specified wiring to be multicore individually identified and colour coded with grey sheath enclosed in conduit or (EMT).

2.5 WIRE & BOX CONNECTORS - GENERAL

.1 Unless otherwise directed, building wire and cable shall be copper conductors, sized as indicated.

.2 Except where otherwise directed or required by Code or other applicable regulations, building wire and cable insulation shall be Type R90, cross-linked polyethylene insulated for 600 volts for #10 AWG and smaller and insulated for 1000 volts for #8 and larger, and rated not less than 90°C.

.3 All conductors within cable trays shall have "plenum" rated (FT6 type) outer jacket to comply with all applicable regulations and bylaws.

2.6 WIRE AND BOX CONNECTORS AND MISCELLANEOUS MATERIALS

.1 Connectors for wire and cable splices and taps: Unless otherwise directed, use 3M Co. 'Scotchlok,' Thomas & Betts PT Series, Buchanan 'B,' IDI Electric 'Super Nut,' or approved equal, for conductors #8 AWG or smaller; Burndy 'Servit' Type KSU or approved equal for conductors #1/0 AWG and smaller; and Burndy 'OKlip' Type KVSU or approved equal for conductors 750 MCM or smaller.

.2 Clamps, glanding connectors, or box connectors for armoured cable, and flexible conduit as required.

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

.4 Plastic electrical insulation tape: Scotch #88 or approved equal.

2.7 WIRE & BOX CONNECTORS - ARMOURED 'BX' CABLES

.1 For all circuits, wires shall be brought from the panel to one or more junction boxes in the room. From any one junction box, a maximum 2.5 meter of cable can be used for motor connection and 5 meter for luminaires.

.2 Receptacles can be wired from a ceiling junction box to wall outlet as a vertical drop using 'BX' cable.

.3 'BX' cable cannot be used from room-to-room.

.4 Separate ground conductor required if 'BX' cable is used.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Unless specifically indicated otherwise, all wiring shall be installed in conduit. Use flexible conduits for final connections to suspend light fixtures and vibrating equipment.

.2 Use no wire smaller than #12 AWG, unless otherwise directed.

.3 Control circuit conductors for motors and mechanical equipment controls shall be not less than #14 AWG except where specifically directed otherwise.

.4 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.

.5 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code. Submit data sheet with values measured.

.6 The number of splices in any circuit shall be kept to an absolute minimum consistent with available coil length and installation conditions.

.7 Conductors for lighting, receptacle, appliance and equipment branch circuits shall have ampacity not less than the rating of the over-current device protecting the branch circuit and shall be sized for a maximum voltage drop of 2% from panelboard to the last outlet of a circuit. The length of the branch circuit to be used in the determination of the required wire size shall be the combined vertical and horizontal distances from the panelboard to the last device in the circuit. In no case shall the wire sizes as determined above, be less than that indicated in the following table.

	120 Volts, 1 Phase
15 Ampere Circuits	20 Ampere Circuits
0-25 m - min. #12 AWG	0-20 m - min. #12 AWG
Over 25 m - min. #10 AWG	0 m-30 m - min. #10 AWG
	Over 30 m - min. #8 AWG
347 Volts, 1 Phase	
15 Ampere Circuits	20 Ampere Circuits
0-75 m - min. #12 AWG	0-55 m - min. #12 AWG
Over 75 m - min. #10 AWG	Over 55 m - min. #10 AWG

.8 Make final connections to recessed incandescent or gas-discharge lamp fixtures, and other heat-producing equipment with thermoplastic insulated, lacquered glass-braid-jacketed "equipment wire," except that where higher temperature rating of insulation or larger conductor size than #10 AWG is required, use wire specifically approved for the purpose.

.9 Exercise care in stripping insulation from wire. Do not nick conductors.

3.2 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 260534.

3.3 INSTALLATION OF ARMORED TECK CABLE 0 - 1000 V

.1 Install cables.

.2 Group cables wherever possible on channels.

.3 Lay cable in cabletroughs or cable trays.

.4 Terminate cables in accordance with Section 260151 - Wire and Box Connectors - 0 - 1000V.

3.4 INSTALLATION OF ARMORED CABLES

.1 Group cables wherever possible.

.2 Terminate cables in watertight connectors, approved for cable installation.

.3 Exercise care in stripping insulation from wire. Do not nick conductors.

3.5 IDENTIFICATION, CODING AND BALANCING

.1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 260500 – Common Work Results - Electrical.

.2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.

.3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.

.4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.

3.6 TESTING

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.

.2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Consultant.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification is to be read, coordinated and implemented in conjunction with all other parts of the Contract Documents.

1.2 REGULATORY REQUIREMENTS

.1 Restraints shall meet the requirements of the latest edition of the BC Building Code and amendments.

.2 The Seismic Consulting Engineer should be able to provide a proof of professional insurance and the related practice credentials if requested by the Consultant.

.3 The Contractor's Seismic Consultant shall submit original signed BC Building Code "Letters of Assurance" "Schedules B and C-B" to the Consultant.

.4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

1.3 SCOPE

.1 It is the responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

.2 Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.

.3 Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.

.4 The total electrical seismic restraint design and field review and inspection will be by a BC registered professional structural engineer who specializes in the restraint of building elements. Contractor shall allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Restraint Engineer. This engineer, herein referred to as the Seismic Consultant, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.

.5 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.

.6 The Seismic Consultant shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.

.7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.

.8 The Seismic Consultant shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.

.9 Include all costs associated with the Seismic installation and certification in the base tender.

1.4 SHOP DRAWINGS & SUBMITTALS

.1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the seismic consultant.

.2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Consultant.

Part 2 Products

2.1 SLACK CABLE SYSTEMS

.1 Slack cable restraint systems shall be as designed and supplied by Vibra-Sonic Control or equal.

.2 Slack cable restraints shall be provided on suspended and shelf mounted transformers along with associated equipment and assemblies connected to them at the points of vertical support (4 points). The restraint wires shall be oriented at approximately 90^{o} to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45^{o} to the slab or basic structure. The restraints shall be selected for a 1 g earthquake loading, i.e. each wire shall have a working load capacity equal to the weight of the transformer. The anchors in the structure shall be selected for a load equal to the weight of the transformers at a 45^{o} pull.

.3 Slack cable systems to allow normal maintenance of equipment and shall not create additional hazard by their location or configurations. Contractor shall rectify any such installations at no additional cost, all to the satisfaction of the Consultant and inspection authority having jurisdiction.

.4 Coordinate requirements of slack cables with suppliers prior to installation.

Part 3 Execution

3.1 GENERAL

.1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.

.2 Ensure that seismic restraints do not adversely affect the proper functioning of any vibration isolation mounts or hangers.

3.2 CONDUITS

.1 Provide restraint installation information and details on conduit and equipment as indicated below:

.2 Vertical Conduit:

.1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.

.2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m [30 ft] o.c.

.3 Riser joints shall be braced or stabilized between floors.

.3 Horizontal Conduits:

.1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.

.2 EMT tubing - tubing shall be supported at approximately 1.2 m [4 ft] intervals for tubing.

.4 Provide transverse bracing at 12.2 m [40 ft] o.c. maximum unless otherwise noted. Provide bracing at all 90^{o} bend assemblies, and pull box locations.

.5 Provide longitudinal bracing at 24.4 m [80 ft] o.c. maximum unless otherwise noted.

.6 Do not brace conduit runs against each other. Use separate support and restraint system.

.7 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.

.8 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.

.9 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

.10 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.

.11 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic consultant and submit shop drawings to the Consultant for his reference.

3.3 FLOOR MOUNTED EQUIPMENT

.1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment which may be subject to resonances, use a nominal 1.0 g seismic force.

.2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 00 - Common Work Results - Electrical

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.2 CSA C22.1-15

.3 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

.4 Transformer grounding shall comply with CSA C22.2 No.41-13

.5 All grounding conductors to be stranded soft annealed copper unless otherwise noted.

1.4 PRODUCT DATA

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

Part 2 Products

2.1 MATERIALS

.1 Grounding equipment to: CSA C22.2 No.41-13

2.2 EQUIPMENT

.1 Clamps for grounding of conductor, size as required.

.2 Copper conductor at least 6m [20’] long for each concrete encased electrode, bare, stranded, soft annealed, size as indicated. If not indicated, use 3/0AWG which is the maximum in Table 43 CEC.

.3 Rod electrodes, copper clad steel 20mm [3/4”] dia by 3m [10’] long as indicated.

.4 System and circuit, equipment, grounding conductors, bare stranded copper, soft annealed, sized as indicated. Insulation where specified to be green.

.5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.6 Non-corroding accessories necessary for grounding system, type, size material as indicated, 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, accessories.

.2 Provide ground wire in EMT conduits installed in grade or below slabs.

.3 Install connectors in accordance with manufacturer's instructions.

.4 Protect exposed grounding conductors from mechanical injury.

.5 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process or permanent mechanical connectors approved for the use.

.6 Use mechanical connectors for grounding connections to equipment provided with lugs.

.7 Soldered joints not permitted.

.8 Install bonding wire for flexible conduit, connected at both end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit. Provide a ground conductor in all flexible conduit and secure to system grounding lugs at both the equipment and source.

.9 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.10 Install separate ground conductor to each outdoor lighting standard.

.11 Connect building structural steel and metal siding to ground by welding copper to steel.

.12 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.13 Bond single conductor, metallic armoured cables to cabinet at supply end and provide non-metallic entry plate at load end.

.14 Ground secondary service pedestals.

.15 Coordinate ground rod installation with local soil conditions to assure proper grounding system.

3.2 GROUNDING GRID ELECTRODES

.1 Provide and install an artificial ground consisting typically of two 3000mm [10'] x 20mm [3/4"] copper weld ground rods, interconnected by bare stranded copper #4/0 conductor and terminating to the Main Electrical Room ground bus. Conductors shall be cad welded to the ground rods and shall be buried 600 mm below grade. Check and measure the installation to ensure an adequate resistance to ground before floor slab cover to be poured.

.2 In certain difficult circumstances, in-situ concrete encased grounding conductors *("UFER")* grounding may be used to enhance grounding grid system.

.3 Provide ground test well over one of the rods on the ground grid to allow access to the grid for testing.

3.3 BUILDING SERVICES GROUNDING

.1 WATER - From the main electrical room ground bus, connect 1#3/0 insulated ground conductor in 27mm [1"] conduit to water main with approved ground clamp ahead of water meter. Install 1#3/0 ground conductor jumper strapped around water meter and associated unions and valves to ground building side of water system.

.2 METALLIC WASTE WATER PIPING - Each metallic waste water piping system to the building to be grounded by bonding it to the interior metallic water supply system by copper bonding jumper of not less than No.6 AWG as per the Canadian Electrical Code

.3 GAS PIPE GROUNDING - All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with requirements of Canadian Electrical Code.

3.4 GROUNDING BUSSES

.1 Provide a ground bus in the main electrical room.

.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 3/0 AWG or as indicated.

.3 Copper or bronze lugs required for termination of all copper conductors at ground busses.

3.5 EQUIPMENT GROUNDING AND BONDING

.1 Install bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, starters, UPS, control panels, building steel work, generators, distribution panels and outdoor lighting.

.2 Provide grounding conductor(s) from all major switchgear to solidly ground the secondary system. This includes equipment located in the main electrical room as well as each sub-electrical room. Grounding conductors to be sized to Canadian Electrical Code and switchgear manufacturer's requirements.

3.6 MECHANICAL EQUIPMENT BONDING

.1 Ground wires to be installed in all conduit serving motor feeder circuits and to extend to ground screws on junction and outlet boxes for bonding.

3.7 SYSTEMS GROUNDING

.1 Install home run a #6 AWG insulated bonding conductor in conduit from the main ground bus to the:

.1 Main Fire Alarm panel
.2 Main Security panel.
.3 Communication systems head end.
.4 Security system head end.
.5 Telephone termination rooms and closets.
.6 CATV system.
.7 Radio Antenna system.

3.8 DATA & VOICE GROUNDING

.1 Install home run insulated ground conductor in conduit from the building main ground bus as follows:

.1 #3/0 AWG to main ground bus in the telecom entrance room.

.2 Unless otherwise solidly bonded, bond all data and telephone incoming and outgoing steel conduits with insulated 1#12 AWG from the nearest “Communication” ground bus.

.3 Provide communications grounding system in accordance detail drawing.

3.9 POST MOUNTED LUMINAIRE GROUNDING

.1 Provide #10 AWG bonding conductor with green RW90 X-link insulation to luminaire standards. Connect to luminaire corrosion resistant ground stud or ground clamp.

3.10 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 260500.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions.

.3 Measure ground grid resistance with earth test megohmmeter and install additional ground rods and conductors as required until resistance to ground complies with Code requirements and is less than 1Ω. Submit test results to Consultant.

.4 Carry out all tests required by the Electrical Inspection Authority and provide all required reports and copied to the Consultant. Include all associated costs.

.5 Ensure test results are satisfactory before energizing the electrical system.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

1.2 RELATED WORK

.1 Section 260500 – Common Work:

.2 Section 260525 - Seismic Restraints:

Part 2 Product

2.1 FRAMING AND SUPPORT SYSTEM

.1 Materials:

.1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

.1 Outdoors, wet locations: Hot dipped galvanized.

.2 Indoors, dry locations: Galvanized when available, prime painted if not available.

.3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut:

.1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 CONCRETE AND MASONRY ANCHORS

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.

.3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 NON-METALLIC ANCHORS

.1 Material: Plastic anchors for sheet metal screws.

.2 Manufacturer: Fischer.

2.4 CONDUIT SUPPORTS

.1 General: Malleable iron two-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.

.2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

.3 Masonry, concrete, stone, etc.: Anchors.

.4 Title: Toggle bolts.

.5 Metal studs, ceiling hangers, etc.: “Caddy-Clips”.

.6 Unistrut: Unistrut conduit clamps.

2.5 CABLE SUPPORTS AND CLAMPS

.1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

Part 3 Execution

3.1 GENERAL

.1 Do not cut or drill beams, joists or structural steel unless written permission of the Engineer is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer’s installation recommendations.

.6 Provide conduit rack with 25% spare capacity for multiple runs.

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.4 Fasten exposed conduit or cables to building construction or support system using straps.

- .1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 50 mm.
- .3 Beam clamps to secure conduit to exposed steel work.

.5 Suspended support systems.

- .1 Support individual cable or conduit runs with 6 mm dia. threaded rods and spring clips.
- .2 Support 2 or more cables or conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.

.6 Shot driven pins may only be used with written approval of the structural engineer.

.7 Use round or pan head screws for fastening straps, boxes, etc.

.8 Do not support heavy loads from the bottom chord of open web steel joists.

.9 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.

.10 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.

.11 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.12 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.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 the Engineer.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 00 - Common Work Results - Electrical

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION BOXES AND PULL BOXES, INDOOR DRY LOCATIONS

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and/or galvanized.

.2 Components:

.1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

.2 Use rolled edges for surface boxes.

.3 Size shall be in accordance with Canadian Electrical Code for the given conduit sizes and arrangement and number of conductors and splices in the boxes.

.4 Surface or flush with trim and hinged door, latch and lock and two keys and keyed to match panelboard keys.

.5 Backboards: 19 mm GIS Fir Plywood backboard.

.3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 CABINETS

.1 Materials:

.1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.

.2 Locks: to match panelboards.

.3 Backboards: 19 mm GIS fir plywood, one piece per cabinet, covering entire cabinet interior.

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to Canadian Electrical Code for the given conduit sizes and arrangement and number of conductors and splices in the boxes. Keyed to match panelboard keys.

Part 3 Execution

3.1 INSTALLATION

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the drawings or required for the installation.

.2 Boxes installed in party walls to be offset by a minimum of one stud space.

.3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.

.4 Identify with system name and circuit designation as applicable.

.5 Size in accordance with the Canadian Electrical Code, as a minimum.

.2 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

.2 Install terminal block where indicated.

.3 Identification

.1 Provide equipment identification in accordance with drawings.

END OF SECTION

Part 1 GENERAL

1.1 Related Work

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 00 - Common Work Results - Electrical

1.3 References

.1 CSA C22.1-15 - Canadian Electrical Codes, Part 1.

1.4 Product Data

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

Part 2 PRODUCTS

2.1 Outlet and Conduit Boxes General

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Outlet Boxes for Metal Conduit

.1 Materials:

.1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 350 g/m² minimum zinc coating.

.2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.

2.3 Junction & Pull Boxes

.1 Electro-galvanized sheet steel type boxes for flush mount in walls with matching extension and plaster rings as required.

.2 Install pull boxes in inconspicuous but accessible locations.

.3 Install pull boxes after cumulative bend total of 270 degrees between boxes.

.4 Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

2.4 Conduit Boxes

.1 Cast FS or electro-galvanized sheet steel boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.5 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

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 plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, and armoured cable connections. Reducing washers are not allowed.

.5 Install all outlets flush and surface mounted as required for the installation.

.6 Surface mount above suspended ceilings, or in unfinished areas.

.7 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.9 Use plaster rings to correct depth. Use 30 mm on concrete block.

.10 Do not use sectional boxes.

.11 Provide boxes sized as required by the Canadian Electrical Code.

.12 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.13 Outlets installed in partition walls to be offset by a minimum of one stud space.

.14 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.

.15 Primary bushings in termination box for cable connection.

.16 Secondary bushings in termination box for bus duct connection.

.17 For telecom raceways provide a pull box where: (1) the length is over 30 m and (2) where there are more than two 90 degree bends.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 00 - Common Work Results – Electrical.

1.3 REFERENCES

.1 CSA C22.1-15 - Canadian Electrical Codes, Part 1.

.2 Canadian Standards Association (CSA) .CAN/CSA C22.2.

1.4 PRODUCT DATA

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

1.5 SCOPE

.1 Drawings do not show all conduits. Those shown are in diagrammatic form only.

.2 Conceal all conduits in finished areas. Conduits may be surface mounted either only where indicated or in service areas accessible only to authorized personnel.

.3 Note particular requirements for routing of conduits where detailed.

.4 Provide polypropylene pull cord in all “empty” conduits.

Part 2 Products

2.1 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No.45 Galvanized Steel.

.2 Electrical Metallic Tubing (EMT): to CSA C22.2 No.83.

.3 Flexible conduits: to CSA C22.2 No. 56.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 27 mm and smaller. Use two hole steel straps to conduits larger than 27 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits.

.4 10 mm [3/8”] threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS

.1 Fittings manufactured for use with conduits specified. Coating same as conduit.

.2 Provide factory "ells" where 90 degree bends are required for 35 mm [1.25”] and larger conduits.

.3 EMT couplings and connectors shall be steel, or Regal Die-cast zinc alloy. Couplings used on conduit containing fire-rated cable shall be steel. Regular die-cast alloy fittings and couplings are not acceptable. Provide plastic bushings (insulated throat) for all connectors unless there is no chance of burrs. Provide water-tight connectors in damp or wet locations and for surface equipment (e.g. Panelboards, MCC’s, etc) in rooms that are fire sprinkler protected.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable linear expansion.

.2 Water-tight expansion fittings: with integral bonding jumper, suitable for linear expansion and 19 mm [3/4”] deflection in all directions.

.3 Weatherproof expansion fittings for linear expansion at entry to panel as required.

2.5 RIGID P.V.C. CONDUIT

.1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride as manufactured C.G.E. "Sceptre" Schedule 40.

.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.

.3 Solvent: as recommended by conduit manufacturer.

2.6 OUTLET AND CONDUIT BOXES IN GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm [4”] square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

.6 Bushing and connectors with nylon insulated throats.

.7 Knock-out fillers to prevent entry of foreign materials.

.8 Conduit outlet bodies for conduit up to 35 mm [1.25”]. Use pull boxes for larger conduits.

.9 Double locknuts and insulated bushings on sheet metal boxes.

2.7 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm [3" x 2" x 1.5"] or as indicated. Larger 102 mm square x 54 mm deep [4”x 2”] outlet boxes (No. 52151 or 52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.

.2 For larger boxes use GSB solid type as required.

.3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.

.4 Lighting fixture outlets: 102 mm [4”] square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).

.5 102 mm [4”] square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

2.8 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi gang type MDB boxes for devices flush mounted in exposed block walls.

2.9 CONCRETE BOXES

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.10 FLOOR BOXES

.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28 mm [1.1”] for receptacles; 73 mm [2.9”] for communication equipment.

.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16 mm [0.5”] and 21 mm [0.75”] conduit. Minimum size: 73 mm [2.9”] deep

2.11 SURFACE CONDUIT BOXES

.1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

Part 3 Execution

3.1 CONDUIT - GENERAL

.1 Generally use electrical metallic tubing (EMT) in the building interior and in above grade slabs except where subject to mechanical injury or where otherwise indicated.

.2 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.

.3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.

.4 At all recessed panels cap 4 - 27 mm empty conduits from panel into ceiling above for future use.

.5 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Set out the work and coordinate with other services prior to installation. Maintain access to junction and pull boxes.

.6 Any conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.7 All conduit ends to be reamed to ensure a smooth interior finish that will not damage the insulation of the wiring.

.8 Ensure grounding continuity in all conduit systems.

.9 Use rigid galvanized steel (RGS) threaded conduit where the installation is subject to mechanical injury. In any event, use RGS conduit for surface installations up to 1.5 m [5’] above the finished floor.

.10 Field threads on rigid conduit shall be sufficient length to draw conduits ends together.

.11 Unless otherwise noted and where practical, all conduits to be routed through the ceiling space rather than in, or below, slabs or floor structures to facilitate future changes.

.12 Conduits in walls should typically drop (or loop) vertically from above to better facilitate future renovations. Generally conduits from below and horizontal conduits in walls and concrete structures should be avoided unless indicated.

.13 All branch circuit conduit, home-runs and communication/data conduits to be minimum 21 mm [3/4”] diameter.

.14 Generally use Rigid PVC conduits in or below ground level slab unless otherwise noted. Transition to RGS conduit in exposed locations: eg where conduits emerge from ground level slab.

.15 Conduits are not permitted in terrazo or concrete toppings.

.16 Cap turned up conduits to prevent the entrance of dirt of moisture during construction.

.17 Locate conduits more than 75 mm [3”] parallel to steam or hot water lines with a minimum of 25 mm [1”] at crossovers.

.18 Bend conduits cold, so that conduit at any point is not flattened more than 1/10th of its original diameter. Conduits bent more than this or kinked to be replaced.

.19 Provide polypropylene pull cord in empty conduits to facilitate pulling wiring in future.

.20 Where conduits become blocked, the use of corrosive agents is prohibited. Remove and replace blocked section.

.21 Damaged conduits to be repaired or replaced.

.22 Dry conduits out thoroughly before installing wiring. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.23 Conduits shall not pass through structural members except as indicated.

.24 Conduit sizes indicated on drawings are minimum only. Increase sizes as required to suit alternative wiring types or to comply with Code.

.25 Conduits and ducts crossing building expansion joints shall have approved conduit expansion fittings to suit the type of conduit used.

.26 Seal conduits with approved sealant where conduits are run between heated and unheated areas.

.27 Seal openings with approved sealant where conduits, cables, or cable trays pierce fire separations.

.28 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction and/or to meet any fire separation integrity.

.29 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.

.30 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of standard boxes where box support is not provided.

.31 Provide necessary roof jacks or flashing where conduits pass through roof or watertight membranes. Apply approved sealant to maintain membrane integrity.

.32 Use flexible metal conduit for connection to recessed incandescent fixtures without a prewired outlet box and connection to recessed fluorescent fixtures.

.33 Use liquid tight flexible metal conduit for connection to motors, and other vibrating equipment and transformers.

.34 Use explosion proof flexible connection for connection to explosion proof motors.

.35 Install conduit-sealing fittings in hazardous areas, isolation rooms and clean rooms. Fill with compound.

3.2 SURFACE CONDUITS

.1 Surface conduits are acceptable in mechanical and electrical service rooms and in unfinished areas or where indicated.

.2 Run parallel or perpendicular to building lines.

.3 Locate conduits behind infrared or gas fired heaters with minimum 1.5 m [5’] clearance.

.4 Conduits to be run in flanged portion of structural steel.

.5 Group conduits wherever possible on suspended and/or surface channels.

.6 Surface conduits will not be accepted in finished areas unless detailed.

3.3 SPARE CONDUITS

.1 Provide spare conduits as indicated.

.2 Provide 4x27 mm [1”] spare conduits up to ceiling space and 4x27 mm [1”] spare conduits down to ceiling space below from each flush panel. Terminate the conduits in 150x150x100 mm [6”x6”x4”] junction boxes in ceiling spaces or in case of an exposed concrete slab, terminate each conduit in a flush concrete box. Provide coverplates for all junction boxes.

3.4 BOXES INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.

.3 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of construction material. Remove upon completion of work.

.4 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm [0.25”] of opening.

.5 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers not to be used.

.6 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.

.7 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.

.8 No sectional or handy boxes to be installed.

.9 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.

.10 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.

.11 Outlets installed back to back in party stud walls to be off-set by one stud space.

.12 Refer to wiring device and communication specification sections and to architectural layouts for mounting heights of outlet boxes.

.13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.

.14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.

.15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers, and ground-fault circuit-interrupters.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 00 - Common Work Results - Electrical

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-C22.2 No. 5-02, 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 PRODUCT DATA

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

.2 Include time-current characteristic curves for breakers with ampacity of 100A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

Part 2 Products

2.1 BREAKERS - GENERAL

.1 Moulded-case circuit breakers, and ground-fault circuit-interrupters, 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 40°C ambient.

.3 Plug-in moulded-case circuit breakers shall not be used.

.4 Common-trip breakers: with single handle for multi-pole applications.

.5 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.

.6 Circuit breakers with interchangeable trips as indicated.

2.2 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.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1 whether indicated on not on the contract drawings.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 26 05 00.

Part 2 Products

2.1 DISCONNECT EQUIPMENT

.1 "Heavy Duty" class, enclosed manual air break switches in non-hazardous locations: to CSA C22.2 No.4.

.2 Fuseholder assemblies to CSA C22.2 No.39.

.3 Fusible and non-fusible disconnect switch in CSA enclosure Type 1, size as indicated.

.4 Provision for padlocking in 'off' switch position.

.5 Fuses as indicated. Allow for Class J or L for general circuits, Class RK5 for transformer, motor or other high inrush current circuits.

.6 Fuseholders in each switch suitable without adaptors, for type of fuse as indicated.

.7 Quick-make, quick-break action.

.8 ON-OFF switch position indication on switch enclosure cover.

.9 Weatherproof as required.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide identification lamicoid for main fused switch.

.2 Indicate name of load controlled on size 4 name plate to Section 26 05 00.

2.3 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Section 26 05 00

.2 For disconnect switch less than 50A, provide two spare disconnect switches for each different size and type.

.3 For disconnect switch 50A or larger, provide one spare disconnect switches for each different size and type.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses where indicated or required.

.2 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1 whether indicated on not on the contract drawings.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

.1 Motor Starters

.2 Motor Control Centres

.3 Motor Distribution Centres

.4 Motor control and power wiring.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 29 - Health and Safety Requirements

.3 Section 01 77 00 - Closeout Submittals

.4 Section 26 05 00 - Common Work – Electrical

1.3 SUBMITTALS

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

.2 Submit product data sheets for sills, bus bars, and compartments. Include product characteristics, physical size, and finish.

.3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures.

.4 Submit shop drawings and indicate:

- .1 Outline dimensions.
- .2 Configuration of identified compartments.
- .3 Floor anchoring method and dimensioned foundation template.
- .4 Cable entry and exit locations.
- .5 Dimensioned position and size of bus bars and details of provision for future extension.
- .6 Schematic and wiring diagrams.

.5 Closeout Submittals: provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.6 Include data for each type and style of starter.

1.4 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Section 26 05 00

.2 Provide listed spare parts for each different size and type of starter:

- .1 1 starter heater.
- .2 1 control transformer.
- .3 5 pilot lights.
- .4 3 contacts, stationary.
- .5 3 contacts, movable.
- .6 1 contact, auxiliary.
- .7 1 operating coil.
- .8 5 fuses.
- .9 1 breaker of each type used in the motor control centre (MCC).

Part 2 PRODUCTS

2.1 MOTOR STARTERS

.1 All motor starters supplied under Division 26 shall be of the same manufacturer.

.2 Motor starters are indicated in the Motor Schedule by letter types in conjunction with numerical suffixes. The letters indicate the type of starter and the numerals indicate special features which must be incorporated into or placed adjacent to the starters as specified.

.3 The following letter types shall apply:

- .1 Type A - Magnetic in general purpose enclosure
- .2 Type B - Magnetic in Motor Control Centre
- .3 Type C - Manual starter in general purpose enclosure
- .4 Type D - Manual open type flush mounted in switchbox and fitted with plate to match other switch plates in the area
- .5 Type E - Manual with special features - see Specification
- .6 Type F - Combination breaker/magnetic starter in an EEMAC I enclosure. Overcurrent device rating shall be as noted in the Motor Schedule. Overcurrent devices to be capable of being locked “OFF" and “ON”
- .7 Type G - Combination unfused switch/magnetic starter in an EEMAC I enclosure
- .8 Type H - Fusible switch in Motor Control Centre
- .9 Type R-2(2SP) - Two-speed relay type starter w/o overload heaters. Locate in EEMACI enclosure. Refer to drawings for wiring diagrams.

.4 The following suffixes shall apply:

.1 Reset only in cover.

.2 Reset and HAND-OFF-AUTOMATIC or LOCAL-OFF-REMOTE switch in cover.

.3 Reset and START-STOP pushbuttons in cover.

.4 Run (red) and Stop (green) PUSH-TO-TEST pilot lights in cover.

.5 Fitted with special features - see Motor Schedule.

.6 Reset and ON-OFF selector switch in cover.

.5 All individual starters shall have RUN and STOP pilot lights, with PUSH-TO-TEST feature, and START/STOP pushbuttons or selector switches as required or indicated.

.6 Starters located in finished areas (other than service spaces) shall be of a flush-mounted type with stainless steel cover.

.7 Fit all motor starters supplied under Division 26 with adjustable electronic overload trips in all normally ungrounded lines.

.8 All magnetic starters, including combination starters provided under Division 26 shall be complete with 4 sets of spare auxiliary contacts (2 sets N/C, 2 sets N/O, all sets reversible). Each and every starter shall have a separate control transformer complete with fused secondary protection at 120 volt, 60 Hz AC. Transformer volt-ampere rating will be confirmed with Mechanical Division prior to ordering. Where line over current protection exceeds 15 amperes, provide primary fuses for the control transformers.

.9 Minimum magnetic starter size shall be CEMA Size 1.

.10 Coordinate with the BMS Controls contractors. Interposing relays required to interface BMS system to the wiring in motor starters shall be provided by BMS Controls Contractor.

.11 Provide interposing relays for fire alarm shutdown of motors as shown in the MECHANICAL EQUIPMENT SCHEDULE Appendix ‘B’.

2.2 MOTOR CONTROL CENTRES

.1 Provide where shown on the drawings and as specified herein motor control centres containing motor starters, control interlocks, pilot lights, and control devices.

.2 Motor Control Centres shall be of sprinkler-proof design. Conduit penetrations shall be sealed using water-tight hubs and/or "O" rings DSM to ensure proper water tight seal.

.3 Motor Control Centres shall consist of standardized vertical sections of 2290 mm height; width and depth as required to house the equipment contained; all joined together to form a rigid, free-standing, completely dead front, EEMAC Type IA enclosed assembly. All units shall be arranged for front access only. All control units shall be wired for EEMAC Class II, Type B modified construction with control wiring brought to terminal board in DDC section. Where shown on the drawings, the Motor Control Centres shall be arranged in a "back-to-back" configuration.

.4 All bus work shall be either silver-plated copper suitable supported to withstand maximum short circuit current of 22,000 RMS amperes symmetrical.

.5 Starter units shall be of the combination type including motor starter, and breaker. All components and wiring shall be readily accessible and shall be connected to the vertical bus with self-aligning plug-on connectors having free-floating spring action. A minimum of one padlock per starter shall be provided on the panel fastener to allow padlocking in either ON or OFF position. All padlocks shall be alike with separate keys. Provide identifications for each padlock and associated key.

.6 Operating handle shall be interlocked with door so that the handle must be in the OFF position before door can be opened. A semi-concealed release shall be provided allowing bypassing of the interlock.

.7 The Contractor for Division 26 must work in close cooperation with the Motor Control Centre supplier, the Mechanical Controls supplier/installer and the Fire Alarm system supplier to ensure that the Standards and requirements of Mechanical Divisions and Electrical division are met. Ensure that sufficient terminal blocks are installed in starter cubicles and master terminal cubicles for all control functions and that sufficient and proper interlocks are installed.

.8 Equipment shall conform to the typical motor control wiring diagram provided within the contract documents.

.9 All wiring and terminals (power and control) shall have number codes corresponding to shop drawing control diagrams.

.10 Motor Control Centres shall be completely factory pre-wired (line and control) for interconnection at the identified terminal blocks by the appropriate parties. Sufficient terminal blocks shall be installed in the starter and master terminal cubicles for all control functions and interlocks, including, but not necessarily limited to, those required by Mechanical Division and the Fire Alarm System.

.11 Motor Control Centres shall be suitable for operation on 600 volts, 3-phase. Provide full capacity neutral when shown on the drawings.

.12 Provide a separate ground bus through all sections of every Motor Control Centre.

.13 Provide spares and spaces as indicated.

.14 Access panels shall be provided and bussing arranged for addition of future sections, as shown on the drawings.

.15 Provide non-ferrous plates and MI cables as specified elsewhere. Connectors and clamps shall also be of non-magnetic material.

2.3 MISCELLANEOUS CONTROL DEVICES

.1 Pushbuttons: Heavy Duty Oil-Tight

.2 Selector Switches: Heavy Duty Oil-Tight

.3 Indicating (Pilot) Lights: Transformer Base PUSH-TO-TEST Type, 12 volt LED indicator lamps. Coordinate the pilot light transformer and circuit voltages such that not more than 12 volts are available at the lamp terminals.

.4 Control Circuit Transformers: Confirm the volt-ampere rating of the control transformer with Mechanical Division prior to ordering.

2.4 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 Magnetic starter designation label, white plate, black letters, size 5 engraved as indicated.

Part 3 EXECUTION

3.1 MOTOR STARTERS

.1 Install, and wire adjacent to the starters, all devices, equipment, and enclosures described in the Mechanical Equipment Schedule with applicable special letter types and suffixes.

.2 Furnish and install for every motor in the building, unless otherwise noted, either a manual or magnetic motor starter as indicated in the Motor Schedule.

.3 Check the actual nameplate current rating of all motors installed before ordering the electronic overloads for motor starters.

3.2 MOTOR CONTROL CENTRES

.1 Where Motor Control Centres are free-standing, they shall be bolted to their housekeeping pads.

.2 Space for future motor control sections shall be provided as shown on the drawings.

3.3 MOTOR CONTROL WIRING

.1 All motor control wiring (120 V line voltage and 24 V low voltage) including conduit as well as supply and installation of control devices will, except where specifically noted on the electrical drawings, in the Motor Schedule, or outlined below, be provided as described in Mechanical Division of the Specification. Except where specifically directed to the contrary, motor control wiring, associated conduits, and control devices do not form a part of Division 26 work.

.2 The motor control work which shall be provided under Division 26 shall include the following:

.1 All conduit and control wiring specifically noted on the drawings and outlined in the different parts of the Specification.

.2 All control wiring as specified in the Mechanical Equipment Schedule.

.3 Control wiring related to air handling shutdown during fire alarm.

3.4 MOTOR POWER WIRING

.1 Connect all motors shown on the drawings or mentioned in this Specification. The locations of motors are approximate only. Check to determine correct locations and install wiring to these points.

.2 Responsibility of supplier and installer is indicated in the Mechanical Equipment Schedule Appendix 'B' in Electrical Specifications. Related mechanical responsibility is indicated on the Mechanical Equipment Schedule on mechanical drawings.

.3 Check motor rotation before mechanically coupling to load.

.4 Except where otherwise directed, connect all motors with flexible conduits. Ground the conduit system with a separate grounding conductor installed in the flexible conduit.

3.5 STARTER VERIFICATION

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

.1 Check of control circuits.

.2 Verify that overload relay installed is correctly sized for motor used.

.3 Record overload relay size and motor nameplate amperage.

.4 Visual inspection of fuses and contactors.

.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.6 OVERLOAD RELAYS

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.7 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 269800 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.

.2 Operate switches, 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