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Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract comprises the AHU replacements at the CSC Bowden Institute, located in Bowden, AB; and further identified interchangeably as "Bowden Institute".

1.2 CONTRACT METHOD

- .1 Construct Work under stipulated price contract.

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit Project construction progress schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements
- .4 Submit site-specific and Work Plan Health and Safety Plan in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 CONTRACTOR USE OF PREMISES

- .1 Co-ordinate use of premises under direction of Owner.
- .2 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .3 Refer to Section 01 52 00 - Construction Facilities and Section 01 56 00 - Temporary Barriers and Enclosures, for temporary facilities, access roads and parking areas, traffic regulations, and utilities.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.
- .6 Ensure that operations conditions of exiting work at completion are still the same, equal to or better than that which existed before new work started.

1.5 OWNER OCCUPANCY

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.6 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.7 EXISTING SERVICES

- .1 Notify Owner, 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 Owner 48 hours notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to tenant operations, pedestrian and vehicular traffic.
- .3 Provide alternative routes for personnel, pedestrian and vehicular traffic as required.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Consultant and Departmental Representative of findings.
- .5 Submit schedule for approval by Owner and Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Departmental Representative to maintain critical building and tenant services.
- .7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .8 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .10 Record locations of maintained, re-routed and abandoned service lines.
- .11 Construct barriers, as required, in accordance with Section 01 56 00 - Temporary Barriers and Enclosures].

1.8 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy of 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.

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- .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 ACCESS AND EGRESS

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

1.2 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.4 EXISTING SERVICES

- .1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental 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 Provide for pedestrian, personnel and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 SPECIAL REQUIREMENTS

- .1 Submit schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart
- .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 Confirm limits to Ingress and egress of Contractor vehicles with Departmental Representative.

1.6 SECURITY

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
- .2 Security clearances:
 - .1 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.
- .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 24 hours before scheduled time of escort. Cost incurred by late request will be Contractor's responsibility.
 - .4 Calculation of costs will be based on average hourly rate of security officer for minimum of 8 hours per day for late service request and of 4 hours for late cancellations.

1.7 BUILDING SMOKING ENVIRONMENT

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

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 REFERENCE STANDARDS

- .1 Owner/Contractor Agreement.

1.2 APPLICATIONS FOR PROGRESS PAYMENT

- .1 Make applications for payment on account as monthly as Work progresses.
- .2 Date applications for payment last day of agreed monthly payment period and ensure amount claimed is for value, proportionate to amount of Contract, of Work performed and Products delivered to Place of Work at that date.
- .3 Submit to Departmental Representative, at least 14 days before first application for payment. Schedule of values for parts of Work, aggregating total amount of Contract Price, to facilitate evaluation of applications for payment.

1.3 PROGRESS PAYMENT

- .1 Departmental Representative will issue to Owner, no later than 10 days after receipt of an application for payment, certificate for payment in amount applied for or in such other amount as Departmental Representative determines to be due. If Departmental Representative amends application, Departmental Representative will give notification in writing giving reasons for amendment.

1.4 SUBSTANTIAL PERFORMANCE OF WORK

- .1 Prepare and submit to Departmental Representative comprehensive list of items to be completed or corrected and apply for a review by Departmental Representative to establish Substantial Performance of Work or substantial performance of designated portion of Work when Work is substantially performed if permitted by lien legislation applicable to Place of Work designated portion which Owner agrees to accept separately is substantially performed. Failure to include items on list does not alter responsibility to complete Contract.
- .2 No later than 10 days after receipt of list and application, Departmental Representative will review Work to verify validity of application, and no later than 7 days after completing review, will notify Contractor if Work or designated portion of Work is substantially performed.
- .3 Departmental Representative: state date of Substantial Performance of Work or designated portion of Work in certificate.
- .4 Immediately following issuance of certificate of Substantial Performance of Work, in consultation with Departmental Representative, establish reasonable date for finishing Work.

1.5 PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF WORK

- .1 After issuance of certificate of Substantial Performance of Work:
 - .1 Submit application for payment of holdback amount.

- .2 Submit sworn statement that accounts for labour, subcontracts, products, construction machinery and equipment, and other indebtedness which may have been incurred in Substantial Performance of Work and for which Owner might in be held responsible have been paid in full, except for amounts properly retained as holdback or as identified amount in dispute.
- .2 After receipt of application for payment and sworn statement, Departmental Representative will issue certificate for payment of holdback amount.
- .3 Where holdback amount has not been placed in a separate holdback account, Owner will, 10 days prior to expiry of holdback period stipulated in lien legislation applicable to Place of Work, place holdback amount in bank account in joint names of Owner and Contractor.
- .4 Amount authorized by certificate for payment of holdback amount is due and payable on day following expiration of holdback period stipulated in lien legislation applicable to Place of Work. Where lien legislation does not exist or apply, holdback amount is due and payable in accordance with other legislation, industry practice, or provisions which may be agreed to between parties. Owner may retain out of holdback amount sums required by law to satisfy liens against Work or, if permitted by lien legislation applicable to Place of Work, other third party monetary claims against Contractor which are enforceable against Owner.

1.6 PROGRESSIVE RELEASE OF HOLDBACK

- .1 Where legislation permits, if Departmental Representative has certified that Work of subcontractor or supplier has been performed prior to Substantial Performance of Work, Owner will pay holdback amount retained for such subcontract Work, or products supplied by such supplier, on day following expiration of holdback period for such Work stipulated in lien legislation applicable to Place of Work.
- .2 In addition to provisions of preceding paragraph, and certificate wording, ensure that such subcontract Work or products is protected pending issuance of final certificate for payment and be responsible for correction of defects or Work not performed regardless of whether or not such was apparent when such certificates were issued.

1.7 FINAL PAYMENT

- .1 Submit application for final payment when Work is completed.
- .2 Departmental Representative will, no later than 10 days after receipt of application for final payment, review Work to verify validity of application. Departmental Representative will give notification that application is valid or give reasons why it is not valid, no later than 7 days after reviewing Work.
- .3 Departmental Representative will issue final certificate for payment when application for final payment is found valid.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

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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 Consultant and Departmental Representative.
- .4 Provide physical space and make arrangements for meetings.
- .5 Preside at meetings.
- .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and all affected parties not in attendance.
- .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 and representatives of Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum 12 days before meeting.
- .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .5 Delivery schedule of specified equipment.
 - .6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
 - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

- .8 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, schedule progress meetings bi-weekly.
- .2 Contractor, major Subcontractors involved in Work, Owner, Consultant and Departmental Representative are to be in attendance.
- .3 Notify parties minimum 7 days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 7 days after meeting.
- .5 Agenda to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period.
 - .9 Review submittal schedules: expedite as required.
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Other business.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

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END OF SECTION

Part 1 General**1.1 DEFINITIONS**

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
- .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
- .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
- .7 Milestone: significant event in project, usually completion of major deliverable.
- .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
- .9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

- .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
- .2 Plan to complete Work in accordance with prescribed milestones and time frame.
- .3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

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- .2 Submit to Departmental Representative & Consultant within 10 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.
- .3 Submit Project Schedule to Consultant & Departmental Representative within 5 working days of receipt of acceptance of Master Plan.

1.4 PROJECT MILESTONES

- .1 Project milestones form interim targets for Project Schedule.
 - .1 Interior finishing and fitting, mechanical, and electrical work completed within 16 weeks of Award of Contract date.
 - .2 Interim Certificate (Substantial Completion) within 20 weeks of Award of Contract date.

1.5 MASTER PLAN

- .1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).
- .2 Departmental Representative will review and return revised schedules within 5 working days.
- .3 Revise impractical schedule and resubmit within 5 working days.
- .4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.6 PROJECT SCHEDULE

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
 - .1 Award.
 - .2 Shop Drawings, Samples.
 - .3 Permits.
 - .4 Mobilization.
 - .5 Excavation.
 - .6 Backfill.
 - .7 Electrical.
 - .8 Fire Systems.
 - .9 Testing and Commissioning.
 - .10 Supplied equipment long delivery items.
 - .11 Engineer supplied equipment required dates.

1.7 PROJECT SCHEDULE REPORTING

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

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- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.8 PROJECT MEETINGS

- .1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.
- .2 Weather related delays with their remedial measures will be discussed and negotiated.

Part 2 Products

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 Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.
- .10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in Alberta, Canada as required by Departmental Representative.
- .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 10 days for Departmental Representative's review of each submission.
- .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

- .6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .7 Accompany submissions with transmittal letter containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .8 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
- .9 After Departmental Representative review, distribute copies.
- .10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.

- .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .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 Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Departmental Representative], no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .21 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that PWGSC 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 Departmental Representative's office.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

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

1.5 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copy of colour digital photography in .jpg format, standard resolution monthly with progress statement, or as directed by Departmental Representative.
- .2 Project identification: name and number of project and date of exposure indicated.

1.6 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 PRECEDENCE

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

1.2 HAZARDOUS MATERIALS

- .1 Follow methods and procedures specified in Section 02 81 00 - Hazardous Materials ; Section 02 56 13 - Waste Containment.
- .2 Provide written reports for chemical spills.
- .3 Provide copies of associated WHMIS Safety Data Sheets (SDS).
- .4 Provide location and layout of storage areas include:
 - .1 Location of water source.
 - .2 Location, type and size of venting equipment. Demonstrate controls and operation to Departmental Representative.
 - .3 Location and contents of spill kits including eye wash stations. Demonstrate contents, operation and use to Departmental Representative.
 - .4 Demonstration and measurements of negative pressure of storage areas.

1.3 EROSION AND SEDIMENTATION CONTROL

- .1 Provide copy of erosion control plan, including drawings with erosion and sedimentation control measures highlighted.

1.4 REDUCING SITE DISTURBANCES

- .1 Provide report indicating measures taken to reduce disturbances to existing topography, vegetation, geology, soils, and drainage.
- .2 Provide site plan indicating location of native species plantings and lawn areas.

1.5 GENERAL CONSTRUCTION MATERIALS/PRACTICES

- .1 Materials and Resources
 - .1 Provide written report indicating:
 - .1 Total amount of granular road base material that was used on site and what percentage of this material was post-consumer demolition material.
 - .2 Which components of project design were reused building materials.
- .2 Storage and Collection of Recyclables
 - .1 Provide floor and site plans indicating:
 - .1 Location of collection sites for recyclable materials and storage facilities in loading dock area.
 - .2 Location of composting facilities.
- .3 Construction Waste Management

- .1 Submit copy of the waste audit and waste management workplan developed for project.
- .2 Submit waybills for waste materials removed from site during construction along with destination point.
- .4 Resource Reuse
 - .1 Provide written report including specifications:
 - .1 Describing salvaged and refurbished materials used during construction, including origin of salvaged materials.
 - .2 Showing calculations that indicate what percentage of total project's materials were salvaged or refurbished.
- .5 Recycled Content
 - .1 Provide product specification and data sheets for products containing recycled content indicating the percentage of , post consumer and post industrial content.
 - .2 Provide calculations indicating what percentage of total project's materials contained recycled content.
- .6 Local/Regional Materials
 - .1 Provide product specification and data sheets for locally manufactured materials installed.
 - .2 Provide calculations indicating what percentage of total project's materials were locally manufactured.
- .7 Rapidly Renewable Materials
 - .1 Provide product specification and data sheets for products containing rapidly renewable materials installed.
 - .2 Provide calculations indicating what percentage of total project's materials contained rapidly renewable materials.
- .8 Wood
 - .1 Provide documentation from supplier declaring that wood materials were harvested from sustainable forestry practices.
 - .2 Provide calculations indicating what percentage of total project's wood materials were certified as sustainably harvested.
- .9 Low-Emitting Materials
 - .1 Provide WHMIS Safety Data Sheets (SDS) or testing results indicating VOC emission rates for following materials:
 - .1 Adhesives.
 - .2 Sealants.
 - .3 Caulkings.
 - .4 Paints and coatings.
 - .5 Textile floor coverings.
 - .2 Provide WHMIS Safety Data Sheets (SDS) sheets indicating resin type for composite wood and agrifibre materials.

1.6 INSULATION

- .1 Provide product specification and data sheets indicating:
 - .1 Recycled content of each type of insulation material installed.

1.7 PAINTS, STAINS, VARNISHES

- .1 Provide WHMIS Safety Data Sheets (SDS) for paints, stains and varnishes indicating VOC emission rate and chemical composition.

1.8 SEALANTS, ADHESIVES AND COMPOUNDS

- .1 Provide WHMIS Safety Data Sheets (SDS) for sealants, adhesives and other compounds indicating VOC emission rate and chemical composition.

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 REFERENCE STANDARDS

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Province of Alberta
 - .1 Occupational Health and Safety Act, R.S.A. – Latest Edition.

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 3 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative.
- .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 Safety Data Sheets (SDS) in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 5 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 5 days after receipt of comments from Departmental Representative.
- .8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.
- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.
- .2 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 Departmental Representative prior to commencement of Work.

1.6 REGULATORY REQUIREMENTS

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

1.7 GENERAL REQUIREMENTS

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.8 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.9 COMPLIANCE REQUIREMENTS

- .1 Comply with Occupational Health and Safety Act, General Safety Regulation, Alberta Reg. (2018 Edition).

1.10 UNFORSEEN HAZARDS

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

1.11 POSTING OF DOCUMENTS

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

1.12 CORRECTION OF NON-COMPLIANCE

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

- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.13 BLASTING

- .1 Blasting or other use of explosives is not permitted.

1.14 POWDER ACTUATED DEVICES

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

1.15 WORK STOPPAGE

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

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section references to laws, by laws, ordinances, rules, regulations, codes, orders of Authority Having Jurisdiction, and other legally enforceable requirements applicable to Work and that are; or become, in force during performance of Work.

1.2 REFERENCES TO REGULATORY REQUIREMENTS

- .1 Department of Justice Canada (Jus)
 - .1 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
 - .2 Perform Work in accordance with 2019 National Building Code of Canada – Alberta Edition (ABC) including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
 - .3 Specific design and performance requirements listed in specifications or indicated on Drawings may exceed minimum requirements established by referenced Building Code; these requirements will govern over the minimum requirements listed in Building Code
 - .1 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.3 HAZARDOUS MATERIAL DISCOVERY

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

1.4 BUILDING SMOKING ENVIRONMENT

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

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Except as otherwise specified, Contractor shall apply for, obtain, and pay fees associated with, permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract and the following:
 - .1 Regulatory requirements and fees in force on date of Bid submission, and

- .2 A change in regulatory requirements or fees scheduled to become effective after date of tender submission and of which public notice has been given before date of tender submission

Part 2 Products

2.1 PERMITS

- .1 Building Permit:
 - .1 Contractor shall apply for, obtain and pay for building permit on behalf of Owner, and other permits required for Work and its various parts.
- .2 Occupancy Permits:
 - .1 Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits where required by authority having jurisdiction.
 - .2 Departmental Representative will issue appropriate instructions to Contractor for correction to Work where Contract Document deficiencies are required to be corrected in order to obtain occupancy permits, including partial occupancy permits.
 - .3 Contractor shall correct deficiencies in accordance with Departmental Representative's instructions. Where deficiency is not corrected, Owner reserves the right to make correction and charge Contractor for costs incurred.
 - .4 Contractor shall turn occupancy permits over to Owner.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 INSPECTION

- .1 Allow Departmental Representative and 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 Departmental Representative or Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction.

1.2 PROCEDURES

- .1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.3 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative or Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Departmental Representative or Departmental Representative 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 Departmental Representative and Consultant.

1.4 REPORTS

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

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- .2 Provide copies to subcontractor of work being inspected or tested, or manufacturer or fabricator of material being inspected or tested if requested.

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 PRECEDENCE

- .1 For Federal Government Projects, Division 01 Sections take precedence over technical specifications in other Divisions of this Project Manual.

1.2 REFERENCE STANDARDS

- .1 Underwriters Laboratories (UL)
 - .1 UL 2761-[11], Sealants and Caulking Compounds
 - .2 UL 2762-[11], Adhesives
 - .3 UL 2768-[11], Architectural Surface Coatings

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submittals required:
 - .1 Compliance Report indicating requirement to purchase energy efficient and environmentally benign products.
 - .2 Use Report indicating understanding of requirement to use materials and methods of construction, which improve energy and water efficiency, reduce hazardous by-products, and use recycled materials, or materials, which can be reused.
 - .3 Building systems and material evaluation report.
- .3 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 43 - Environmental Procedures & 01 35 29.06 - Health and Safety Requirements. Indicate VOC emissions, prior to installation or use:
 - .1 Adhesives.
 - .2 Caulking compounds.
 - .3 Sealants.
 - .4 Insulating materials.
 - .5 Fireproofing or fire stopping materials.
 - .6 Paints.
 - .7 Floor and wall patching or levelling materials.
 - .8 Lubricants.
- .4 Construction Schedule:
 - .1 Submit schedule of construction prior to start of work, in co-ordination with scheduling requirements, including:
 - .1 Sequence of finish applications and allowances for curing times.
 - .2 Identification of finish types. See Table A
 - .3 Schedule and duration of proposed temporary ventilation.

- .4 Delivery schedules of manufactured materials which are anticipated to off-gas in timely manner, which will allow for airing of those materials prior to their scheduled installation.
- .5 Indicate and schedule commissioning procedures and temporary usages of building mechanical systems, identifying types of filtration and schedule for filter replacement.
- .5 IAQ Management Plan:
 - .1 Submit Indoor Air Quality (IAQ) Management Plan for construction and preoccupancy phases of building.

1.4 HAZARDOUS MATERIALS

- .1 Follow methods and procedures specified in Section 02 81 00 - Hazardous Materials ; Section 02 56 13 - Waste Containment.
- .2 Take measures to ensure chemical spills do not enter drains.
- .3 Provide proper storage and containment of herbicides and indoor pesticides.
 - .1 Design and construction of storage spaces for hazardous materials in accordance with authorities having jurisdiction.
 - .2 Include ventilation of areas, which contain potential sources of air contamination.
 - .1 Comply with standards for storage of flammable, combustible and hazardous materials, explosives, compressed gas cylinders, and reactive, corrosive and oxidizing materials.
 - .3 Storage conditions, ventilation requirements, construction materials storage areas, containers, drums and tanks, compatibility issues, and labelling: in accordance with federal and municipal guidelines supplemented as follows:
 - .1 Confine storage of chemicals and hazardous wastes to designated areas with security of access.
 - .2 Ensure access to hose bib and water for mixing concentrated chemicals.
 - .3 Include containment to prevent spills from entering drains.
 - .4 Include venting to exterior.
 - .5 Keep storage areas under negative pressure, where possible.

1.5 PAINTS, STAINS, AND VARNISHES

- .1 Use paints and coatings with VOC limits to UL 2768, GC-03, SCAQMD Rule 1113, CCD-048, and GS-11.

1.6 ADHESIVES, SEALANTS, AND CAULKING COMPOUNDS

- .1 Use adhesives with VOC limits to UL 2762, and SCAQMD Rule 1168.
- .2 Use sealant and caulking products with VOC limits to SCAQMD Rule 1168 and UL 2761.

1.7 EXTERIOR SITE

- .1 Take measures to prevent soil erosion before, during, and after construction by controlling storm-water runoff and wind erosion.

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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 REFERENCE STANDARDS

- .1 Canadian General Standards Board (CGSB)
 - .1 CGSB 1.59-[97], Alkyd Exterior Gloss Enamel.
 - .2 CAN/CGSB 1.189-[00], Exterior Alkyd Primer for Wood.
- .2 CSA Group (CSA)
 - .1 CSA-O121-[M1978 (R2003)], Douglas Fir Plywood.
- .3 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as Of: May 14, 2004.

1.2 INSTALLATION AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

1.3 GUARD RAILS AND BARRICADES

- .1 Provide secure, rigid guard rails and barricades around excavations.

1.4 ACCESS TO SITE

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

1.5 PUBLIC TRAFFIC FLOW

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

1.6 FIRE ROUTES

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

1.7 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.

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1.8 WASTE MANAGEMENT AND DISPOSAL

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

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 REFERENCE STANDARDS

- .1 Within text of each specifications section, reference may be made to reference standards.
- .2 Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .3 If there is question as to whether products or systems are in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.
- .4 Cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

1.2 QUALITY

- .1 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.
- .3 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .4 Should disputes arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.3 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.

- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.4 TRANSPORTATION

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

1.5 MANUFACTURER'S INSTRUCTIONS

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

1.6 QUALITY OF WORK

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

1.7 CO-ORDINATION

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.8 CONCEALMENT

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

1.9 REMEDIAL WORK

- .1 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.

1.10 LOCATION OF FIXTURES

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Departmental Representative of conflicting installation. Install as directed.

1.11 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.12 FASTENINGS - EQUIPMENT

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

1.13 PROTECTION OF WORK IN PROGRESS

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

1.14 EXISTING UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, building occupants. and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

Part 2 Products

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.
- .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, including excavation and fill, 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 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .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 to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 Provide firestopping in accordance with Section 07 84 00 - Firestopping to maintain the integrity of fire separations, including:
 - .1 Protecting penetrations at fire-resistance rated wall, ceiling or floor construction.
 - .2 Using construction joint fire stops and building perimeter fire stops to protect gaps at fire separations and between fire separations and other construction assemblies.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Conceal pipes, 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 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 Clear snow and ice from access to building, bank/pile snow in designated areas only.
- .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 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .9 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .10 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris including that caused by Owner or other Contractors.
- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.

- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .20 Remove snow and ice from access to building.

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 Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
 - .2 Request Departmental Representative's inspection.
 - .2 Departmental Representative's Inspection:
 - .1 Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.
 - .2 Contractor to correct Work as directed.
 - .3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:
 - .1 Work: completed and inspected for compliance with Contract Documents.
 - .2 Defects: corrected and deficiencies completed.
 - .3 Equipment and systems: tested, adjusted and fully operational.
 - .4 Certificates required by Fire Commissioner: submitted.
 - .5 Operation of systems: demonstrated to Owner's personnel.
 - .6 Work: complete and ready for final inspection.
 - .4 Final Inspection:
 - .1 When completion tasks are done, request final inspection of Work by Departmental Representative and Contractor.
 - .2 When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.
 - .5 Declaration of Substantial Performance: when Departmental Representative 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 Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

- .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 00 - 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 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-warranty Meeting:
 - .1 Convene meeting one week prior to contract completion with Departmental Representative, in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify Project requirements.
 - .2 Review warranty requirements.
 - .2 Departmental Representative to establish communication procedures for:
 - .1 Notifying construction warranty defects.
 - .2 Determine priorities for type of defects.
 - .3 Determine reasonable response time.
 - .3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.
 - .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative final copies of operating and maintenance manuals in English.
- .3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.
- .4 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

- .1 Organize data as instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings.
 - .1 Identify contents of each binder on spine.
- .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, 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.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

- .1 Table of Contents for Each Volume: provide title of project;
 - .1 Date of submission; names.
 - .2 Addresses, and telephone numbers of Departmental Representative and Contractor with name of responsible parties.
 - .3 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data.
 - .1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section [01 45 00 - Quality Control].
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.5 AS -BUILT DOCUMENTS AND SAMPLES

- .1 Maintain, at site Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field Test Report, System Components List C/W Commissioning Verification Forms and Check Sheets and Commissioning Issues/Resolution Log. Inspection certificates.
 - .7 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction.
 - .1 Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
 - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition.
 - .1 Do not use record documents for construction purposes.

- .5 Keep record documents and samples available for inspection by Departmental Representative.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

- .1 Record information on set of black line opaque drawings provided by Departmental Representative.
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress.
 - .1 Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 Referenced Standards 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 field test records, inspection certifications, and manufacturer's certifications 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 Include installed colour coded wiring diagrams.
- .3 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.

- .4 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .5 Provide servicing and lubrication schedule, and list of lubricants required.
- .6 Include manufacturer's printed operation and maintenance instructions.
- .7 Include sequence of operation by controls manufacturer.
- .8 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .9 Provide installed control diagrams by controls manufacturer.
- .10 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .11 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .12 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .13 Include test and balancing reports as specified in Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS
- .14 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.
 - .1 Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 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 Departmental Representative.
 - .2 Include approved listings in Maintenance Manual.
 - .5 Obtain receipt for delivered products and submit prior to final payment.
- .2 Extra Stock Materials:

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site; place and store.
- .4 Receive and catalogue items.
 - .1 Submit inventory listing to Departmental Representative.
 - .2 Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.
- .3 Special Tools:
 - .1 Provide special tools, in quantities specified in individual specification section.
 - .2 Provide items with tags identifying their associated function and equipment.
 - .3 Deliver to site ; place and store.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Departmental Representative.
 - .2 Include approved listings in Maintenance Manual.

1.10 DELIVERY, STORAGE AND HANDLING

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and for review by Departmental Representative.

1.11 WARRANTIES AND BONDS

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Departmental Representative approval.
- .3 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within [ten] days after completion of applicable item of work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 6 month and 12 month warranty inspection, measured from time of acceptance, by Departmental Representative and Consultant.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
 - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include sprinkler systems, alarm systems, fire protection.
 - .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
 - .4 Contractor's plans for attendance at 6 and 12 month post-construction warranty inspections.
 - .5 Procedure and status of tagging of equipment covered by extended warranties.
 - .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

- .10 Respond in timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification to follow oral instructions.
 - .1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.12 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

Part 2 Products

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 final inspection
- .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 in accordance with relevant Sections.
 - .4 Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS 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.

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 Departmental Representative'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 Description of overall structure of Plan and roles and responsibilities of commissioning team.

1.2 REFERENCE STANDARDS

- .1 CSA -Z320-11 - Building Commissioning Standard.Public Works and Government Services Canada (PWGSC)
- .2 ASHRAE 202-2013 – Commissioning Process for Building and System.
- .3 Underwriters' Laboratories of Canada (ULC)

1.3 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 and within specified energy budgets under normal loads.
 - .2 Facility user and O&M personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Term “Cx”; in this section means “Commissioning”;
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to O&M, process and administration of Cx.
 - .4 Describes process of verification of how built works meet design and Owner requirements.
 - .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
 - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.
- .4 Acronyms:

- .1 Cx - Commissioning.
- .2 BMM - Building Management Manual.
- .3 EMCS - Energy Monitoring and Control Systems.
- .4 WHMIS Safety Data Sheets (SDS).
- .5 PI - Product Information.
- .6 PV - Performance Verification.
- .7 TAB - Testing, Adjusting and Balancing.
- .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
 - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
 - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

- .1 Cx Plan to be 95% completed before added into Project Specifications.
- .2 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .3 Submit completed Cx Plan to Departmental Representative and obtain written approval.

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
- .2 Revise, refine and update every month during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Departmental Representative 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 Departmental Representative Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
- .2 Departmental Representative Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
- .3 Departmental Representative is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying TAB and other tests.
 - .5 Developing BMM.
 - .6 Ensuring implementation of final Cx Plan.
 - .7 Performing verification of performance of installed systems and equipment.
 - .8 Implementation of Training Plan.
- .4 Construction Team: contractor, subcontractors, suppliers and support disciplines, is responsible for construction/installation in accordance with Contract Documents, including:
 - .1 Testing.
 - .2 TAB.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.
 - .5 Assigning one person as point of contact with Departmental Representative and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
 - .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
 - .5 Client: responsible for intrusion and access security systems.
 - .6 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
 - .7 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Cx Structural and Architectural Systems:
 - .1 Architectural and structural:
 - .1 Beam and slab deflection:
- .2 Commission mechanical systems and associated equipment:
 - .1 HVAC and exhaust systems:
 - .1 HVAC systems.
 - .2 Noise and vibration control systems for mechanical systems.
 - .3 Seismic restraint and control measures.

- .4 IAQ environmental control systems:
 - .1 Indoor conditions
 - .2 Indoor air quality (IAQ)
- .5 EMCS:

1.9 DELIVERABLES RELATING TO O&M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 WHMIS Safety Data Sheets (SDS).
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.
 - .8 Preventive maintenance program.
 - .9 Standard Operating Procedures (SOP).
 - .10 Contractor's and sub-contractors' as built drawings.

1.10 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 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.

- .8 Description of Cx of integrated systems and documentation.
- .9 Tests performed by Owner/User.
- .10 Training Plans.
- .11 Cx Reports.
- .12 Prescribed activities during warranty period.
- .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.
- .5 Departmental Representative to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
 - .2 Departmental Representative to use approved check lists.
 - .3 Departmental Representative will monitor of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping"; during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.
 - .6 Departmental Representative will monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - ARCHITECTURAL AND STRUCTURAL:
 - .1 Slab and beam deflection test: test after removal of temporary supports and concrete has cured to ensure adequacy for raised floors.
- .3 Pre-Cx activities - MECHANICAL:
 - .1 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone"; mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Departmental Representative.
 - .2 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.

- .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
- .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
- .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".

1.12 START-UP

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
 - .1 HVAC System
- .3 Departmental Representative to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative .
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Departmental Representative to witness and certify reported results using approved PI and PV forms.
 - .4 Departmental Representative to approve completed PV reports and provide to Departmental Representative.
 - .5 Departmental Representative reserves right to verify up to 30 % of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx by specified Cx agency using procedures developed by Departmental Representative and Consultant and approved by Departmental Representative.
- .2 Departmental Representative to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Departmental Representative to witness, certify reported results of, Cx activities and forward to Departmental Representative.
- .5 Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx to be performed by specified Cx specialist, using procedures developed by Departmental Representative and Consultant and approved by Departmental Representative.
- .2 Tests to be witnessed by Departmental Representative and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Departmental Representative and submitted to Departmental Representative for review.
- .4 Departmental Representative reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 HVAC and associated systems forming part of integrated HVAC systems:
 - .2 Indoor air quality.
 - .3 Environmental space conditions.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Departmental Representative, Contractor, Departmental Representative, and Cx Manager to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

- .1 General:
 - .1 Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.19 CX SCHEDULES

- .1 Prepare detailed Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:

- .1 Design criteria, design intents.
- .2 Pre-TAB review: [28] days after contract award, and before construction starts.
- .3 Cx agents' credentials: [60] days before start of Cx.
- .4 Cx procedures: [3] months after award of contract.
- .5 Cx Report format: [3] months after contract award.
- .6 Discussion of heating/cooling loads for Cx: [3] months before start-up.
- .7 Submission of list of instrumentation with relevant certificates: [21] days before start of Cx.
- .8 Notification of intention to start TAB: [21] days before start of TAB.
- .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
- .10 Notification of intention to start Cx: [14] days before start of Cx.
- .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed [14] days before start of integrated system Cx.
- .12 Identification of deferred Cx.
- .13 Implementation of training plans.
- .14 Cx reports: immediately upon successful completion of Cx.
- .15 Emergency evacuation exercises: after 80 %.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to CSC.
- .3 [6] months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Departmental Representative, Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.

1.20 CX REPORTS

- .1 Submit reports of tests, witnessed and certified by Departmental Representative and Consultant to Departmental Representative 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 Departmental Representative.

1.21 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 reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.

- .3 Full-scale emergency evacuation exercises.

1.22 TESTS TO BE PERFORMED BY OWNER/USER

- .1 None is anticipated on this project.

1.23 TRAINING PLANS

- .1 Refer to Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

1.24 FINAL SETTINGS

- .1 Upon completion of Cx to satisfaction of Departmental Representative 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 INSTALLATION/START-UP CHECK LISTS

.1 Include the following data:

- .1 Product manufacturer's installation instructions and recommended checks.
- .2 Special procedures as specified in relevant technical sections.
- .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Departmental Representative supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Departmental Representative. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Departmental Representative's approval.

1.4 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 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Departmental Representative's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

- .1 Departmental Representative will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
- .2 Revise items on Commissioning forms to suit project requirements.
- .3 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Departmental Representative or Departmental Representative develop appropriate verification forms and submit to Departmental Representative for approval prior to use.
 - .1 Additional commissioning forms to be in same format as provided by Departmental Representative

1.7 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Departmental Representative provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Departmental Representative.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Departmental Representative with originals of completed forms.
 - .12 Maintain copy on site during start-up, testing and commissioning period.
 - .13 Forms to be both hard copy and electronic format with typed written results in Building Management Manual in accordance with Section 01 92 00 - Facility Operation.

1.8 LANGUAGE

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

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

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the BMM.
 - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 Section 01 91 13.13 - Commissioning Plan.
- .2 For Cx responsibilities refer to Section 01 91 13.13 - Commissioning Plan.

- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .6 Departmental Representative will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
 - .2 Equipment, components, systems, and integrated systems have been fully commissioned and functional as per design intent to meet contract specification and project functional and operational requirements.
 - .3 Completion of Training session to Operational and Maintenance staffs.
 - .4 Final O&M and Training Manual receive, review and approve by Departmental Representative for suitability.
 - .5 Successful completion of integrated system tests, and after meeting all requirements of the authority having jurisdiction.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review Contract Documents, confirm by writing to Departmental Representative:
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.

- .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
- .3 Fully understand Cx requirements and procedures.
- .4 Have Cx documentation shelf-ready.
- .5 Understand completely design criteria and intent and special features.
- .6 Submit complete start-up documentation to Departmental Representative.
- .7 Have Cx schedules up-to-date.
- .8 Ensure systems have been cleaned thoroughly.
- .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
- .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative 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 Departmental Representative for changes to submittals and obtain written approval at least [8] weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to Departmental Representative 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 Departmental Representative or Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms for requirements and instructions for use].
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Departmental Representative.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.10 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meetings: Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart and as specified herein.
- .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. Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart. Departmental Representative 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 Departmental Representative, 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 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice prior to commencement.
- .2 Departmental Representative to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Departmental Representative.
 - .3 Arrange for Departmental Representative and/or Departmental Representative to witness tests.
 - .4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative 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 Departmental Representative. If results

reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

- .1 Notify Departmental Representative and Consultant at least 21 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS/EQUIPMENT

- .1 Submit to Departmental Representative for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under 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.

1.21 WITNESSING COMMISSIONING

- .1 Departmental Representative and/or Departmental Representative to witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

1.23 EXTRAPOLATION OF RESULTS

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

1.24 EXTENT OF VERIFICATION

- .1 Laboratory areas:
 - .1 Provide manpower and instrumentation to verify up to 100 % of reported results.
- .2 Elsewhere:

- .1 Provide manpower and instrumentation to verify up to 30 % of reported results, unless specified otherwise in other sections.
- .3 Number and location to be at discretion of Departmental Representative.
- .4 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .5 Review and repeat commissioning of systems if inconsistencies found in more than 20 % of reported results.
- .6 Perform additional commissioning until results are acceptable to Departmental Representative.

1.25 REPEAT VERIFICATIONS

- .1 Assume costs incurred by Departmental Representative for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Departmental Representative's and/or Departmental Representative's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Departmental Representative deems Contractor's request for second verification was premature.

1.26 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.27 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative.
- .2 Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

1.28 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative and Consultant.

1.29 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.30 TRAINING

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

1.31 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.32 OCCUPANCY

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

1.33 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Departmental Representative.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.34 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10 % of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.35 OWNER'S PERFORMANCE TESTING

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION



Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA A23.1-14 /A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA O86-14, Engineering Design in Wood.
 - .3 CSA O121-17, Douglas Fir Plywood.
 - .4 CSA O151-17, Canadian Softwood Plywood.
 - .5 CSA O153-13, Poplar Plywood.
 - .6 CAN/CSA O325.0-16, Construction Sheathing.
 - .7 CSA O437 Series-93 (R2011), Standards for OSB and Waferboard.
 - .8 CSA S269.1-16, Falsework and Formwork.
 - .9 CAN/CSA S269.3-M92 (R2013), Concrete Formwork.
- .2 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-17, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in formwork liners and coatings and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 43 - Environmental Procedures and 01 35 29.06 - Health and Safety Requirements.
- .3 Submit shop drawings for formwork.
 - .1 Prepare Shop Drawings in accordance with CSA S269.1 for formwork and falsework.
- .4 Sustainable Design Submittals:
 - .1 Low-Emitting Materials:
 - .1 Submit listing of form release agents used in building, comply with VOC and chemical component limits or restriction requirements.

1.3 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements and according to 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 off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect formwork from damages.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Materials and resources in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Section 01 33 29 - Sustainable design reporting.
- .3 Formwork materials:
 - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA O121, CSA O153, CAN/CSA O86, CSA O437 Series.
 - .2 For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.
 - .3 Rigid insulation board: to CAN/ULC-S701.
- .4 Form ties:
 - .1 For concrete not designated 'Architectural': removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes minimum 25 mm diameter in concrete surface.
 - .2 For Architectural concrete; snap ties complete with plastic cones and light grey concrete plugs.
- .5 Form release agent: Proprietary, non volatile material not to stain concrete or impair subsequent application of finishes or coatings to surface of concrete, derived from agricultural sources, non petroleum containing, biodegradable, low VOC, non-toxic,.
- .6 Falsework materials: to CSA S269.1.
- .7 Sealant: to Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 EXAMINATION

- .1 Before starting this work, examine work done by others which affects this work.
- .2 Notify the Department Representative of any conditions which would prejudice proper completion of this work.

- .3 Commencement of work implies acceptance of existing conditions.

3.2 FABRICATION AND ERECTION

- .1 Verify lines, levels, and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Obtain Department Representative's approval for use of earth forms framing openings not indicated on drawings.
- .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .4 Fabricate and erect falsework in accordance with CSA S269.1.
- .5 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
- .6 Do not place shores and mud sills on frozen ground.
- .7 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .8 Fabricate and erect formwork in accordance with CAN/CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.
- .9 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
- .10 Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners, joints, unless specified otherwise.
- .11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .12 Construct forms for architectural concrete, and place ties as indicated.
 - .1 Joint pattern not necessarily based on using standard size panels or maximum permissible spacing of ties.
- .13 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .14 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.
- .15 Arrange forms to allow removal without removal of principal shores, where these are required to remain in place.
- .16 Provide falsework to ensure stability of formwork. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.
- .17 Check and readjust formwork to required lines and levels during placing of concrete.
- .18 Where construction joints are required in beams and suspended slabs, submit proposed joint locations to Department Representative for review and approval prior to proceeding.

3.3 INSERTS/EMBEDDED ITEMS/OPENINGS

- .1 Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.
- .2 Accurately locate and set in place items which are to be cast directly into concrete.
- .3 Coordinate work of other Sections and co operate with trades involved in forming openings, slots, recesses, chases, and setting sleeves, bolts, anchors and other inserts.
- .4 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- .5 Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so no leakage occurs and to provide uniform surface on exposed concrete.

3.4 TOLERANCE

- .1 Construct formwork to produce concrete with dimensions, lines and levels within the following tolerances. Tolerances are not cumulative.
- .2 Deviation from vertical line: 6mm in 3m, 9mm in 6m and 20mm in 12m or more.
- .3 Deviation from flat surface, for walls and floors: 3mm in 3m.
- .4 Deviation from horizontal line: 6mm in 3m.
- .5 Deviation of linear building lines from drawings and position of columns, walls and partitions: 5 mm.
- .6 Deviation in cross sectional dimensions of columns and beams, and in thickness of slabs and walls: plus or minus 6mm.

3.5 FIELD QUALITY CONTROL

- .1 Inspect and check completed formwork, falsework, shoring and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties and parts are secured.
- .2 Inform Department Representative when formwork is complete and has been cleaned, to allow for inspection. Inspection will be for verification that earth bottoms are clean, that forms are clean and free from debris.
- .3 For architecturally finished concrete surfaces, do not re use wood type formwork more than 3 times without prior inspection and approved by the Architect. Do not patch formwork

3.6 REMOVAL AND RESHORING

- .1 Remove formwork when concrete has reached 75 % of its 28 day design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .2 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .3 Space reshoring in each principal direction at not more than 1500 mm apart.

- .4 Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION



Part 1 General

03/10/2021

1.1 PRICE AND PAYMENT PROCEDURES

- .1 Measurement and Payment:
 - .1 Measure reinforcing steel in tonnes of steel incorporated into Work, computed from theoretical unit mass specified in CSA G30.18 for lengths and sizes of bars as indicated or authorized in writing by Departmental Representative
 - .2 No measurement made under this Section.
 - .1 Include reinforcement costs in items of concrete work in Section 03 30 00 - Cast-In-Place Concrete.

1.2 REFERENCE STANDARDS

- .1 American Concrete Institute (ACI)
 - .1 SP-66-04, ACI Detailing Manual 2004.
- .2 ASTM International (ASTM)
 - .1 ASTM A123/A123M - 15 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A143/A143M-07 (2014), Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .3 ASTM A641/A641M-09a(2014), Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .4 ASTM A775/A775M-17, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - .5 ASTM A884/A884M-14 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
 - .6 ASTM A1064/A1064M-17, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .3 Canada Green Building Council (CaGBC)
 - .1 LEEDv4 Canada-BD+C 2013, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package New Construction and Major Renovation.
 - .2 LEEDv4 Canada-BD+C 2013, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package Core and Shell Development.
 - .3 LEEDv4 Canada-ID+C 2013, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
 - .4 LEEDv4 Canada fO+M2013, LEED (Leadership In Energy and Environmental Design): Green Building Rating System Reference Guide Existing Buildings, Operations and Maintenance.

- .4 CSA Group (CSA)
 - .1 CSA A23.1-14 /A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA A23.3-14, Design of Concrete Structures.
 - .3 CSA G30.18-09 (R2014), Carbon Steel Bars for Concrete Reinforcement.
 - .4 CSA G40.20/G40.21-13 (R2018), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CSA W186-M1990 (R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .5 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC-2018, Manual of Standard Practice.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance with Section 01 31 19 - Project Meetings, convene pre-installation meeting one week prior to beginning concrete works.
 - .1 Ensure [Consultant] [concrete producer] [testing laboratories] [site supervisor,] [Departmental Representative] [DCC Representative] [key personnel,] [speciality contractor - finishing, forming] attend.
 - .1 Verify project requirements.

1.4 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 proprietary materials used in Cast-In-Place Concrete and additives and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Submit 2 copies of WHMIS Safety Data Sheet (SDS) in accordance with Sections 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Alberta, Canada.
 - .1 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice.
 - .2 Indicate placing of reinforcement and:
 - .1 Bar bending details.
 - .2 Lists.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by the Department Representative, with

identifying code marks to permit correct placement without reference to structural drawings.

- .3 Detail lap lengths and bar development lengths to CAN/CSA A23.3, unless otherwise indicated in drawings.
- .4 Indicate position and size of openings in slabs and walls. Coordinate with trades requiring openings.
- .4 Sustainable Design Submittals:
 - .1 LEED Canada submittals: in accordance with [Section 01 35 21 - LEED Requirements].
 - .2 Construction Waste Management:
 - .1 Submit project [Waste Management Plan] [Waste Reduction Workplan] highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating [75] [50] % of construction wastes recycled or salvaged.
- .5 Quality Assurance Submittals:
 - .1 Submit in accordance with Section 01 45 00 - Quality Control and as described in PART 2 - SOURCE QUALITY CONTROL.
 - .2 Mill Test Report: upon request, submit to the Department Representative a certified copy of mill test report of reinforcing steel.

1.5 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 in dry location, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop [Construction Waste Management Plan] [Waste Reduction Workplan] related to Work of this Section and in accordance with Section [01 35 21 - LEED Requirements].

Part 2 Products

2.1 MATERIALS

- .1 Substitute different size bars only if permitted in writing by the Department Representative.
- .2 Reinforcing steel: billet steel, grade 400 deformed bars to CSA G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CSA G30.18.

- .4 Cold-drawn annealed steel wire ties: to ASTM A1064/A1064M.
- .5 Deformed steel wire for concrete reinforcement: to ASTM A1064/A1064M.
- .6 Welded steel wire fabric:
 - .1 Plain in accordance ASTM A1064/A1064M, fabricated from as drawn steel wire into flat sheets; sizes as indicated on Drawings.
 - .2 Finish:
 - .1 Galvanized: [Fabricated from galvanized wire] [Hot dip galvanized after welding] having Class A coating in accordance with ASTM A641/A641M.
 - .3 Provide in flat sheets only.
- .7 Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.
- .8 Concrete Bricks: specifically designed for support of reinforcing bars earth forms. Broken concrete blocks and wood supports are not acceptable.
- .9 Tie wire: 1.5 mm diameter annealed wire
 - .1 Use epoxy coated tie wire where Galvanized steel is used.
- .10 Mechanical splices: subject to approval of the Department Representative.
- .11 Plain round bars: to CSA G40.20/G40.21.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with to CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain Department Representative's written approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of Department Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.
- .5 All bending shall be done cold with a suitable machine accurately producing all lengths, depths and radii shown on the bending details.
- .6 After initial fabrication, reinforcing steel shall not be re-bent or straightened unless so indicated on the drawings.
- .7 Heating of reinforcing steel will not be permitted.
- .8 Locate reinforcing splices not indicated on drawings at points of minimum stress.
- .9 Fabricate within the following tolerances:
 - .1 Sheared length: $\pm 25\text{mm}$.
 - .2 Depth of truss bars: plus 0, minus 10mm.
 - .3 Stirrups, ties and spirals: $\pm 10\text{mm}$.
 - .4 Other bends: $\pm 25\text{mm}$.

2.3 SOURCE QUALITY CONTROL

- .1 Upon request, provide Department Representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum [4] weeks prior to beginning reinforcing work.
- .2 Upon request inform Department Representative of proposed source of supplied material.

Part 3 Execution

3.1 EXAMINATION

- .1 Before starting this work, examine work done by others which affects this work.
- .2 Notify the Department Representative of any conditions which would prejudice proper completion of this work.
- .3 Commencement of work implies acceptance of existing conditions.

3.2 FIELD BENDING

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by the Department Representative.
- .2 When field bending authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

3.3 PLACING REINFORCEMENT

- .1 Cutting or puncturing vapour retarder is not permitted; repair damage and reseal vapour retarder before placing concrete.
- .2 Place reinforcing steel as indicated on placing drawings in accordance with CSA A23.1/A23.2.
- .3 Chair slab reinforcing not further apart than 1.2m in either direction unless noted otherwise.
- .4 Adequately support reinforcing and secure against displacement within tolerances permitted.
- .5 Place reinforcing steel to provide concrete cover required by CAN/CSA A23.1.
- .6 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
 - .2 Apply thick even film of mineral lubricating grease when paint is dry.
- .7 Prior to placing concrete, obtain Department Representative's approval of reinforcing material and placement.
- .8 Maintain cover to reinforcement during concrete pour.

3.4 FIELD TOUCH-UP

- .1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.

3.5 FIELD QUALITY CONTROL

- .1 Site tests: conduct tests as follows in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .1 Epoxy coating.
 - .2 Reinforcing steel and welded wire fabric.
 - .3 Other [_____]
- .2 Inspection and testing of reinforcing and reinforcing materials carried out by testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.
 - .1 Ensure testing laboratory certified to CSA A283.
- .3 Ensure test results distributed for discussion at pre-pouring concrete meeting between testing laboratory and Departmental Representative.
- .4 Departmental Representative will pay for costs of tests as specified in Section 01 29 83 - Payment Procedures for Testing Laboratory Services.
- .5 Inspection or testing by Consultant not to augment or replace Contractor quality control nor relieve Contractor of contractual responsibility.
- .6

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling, reuse in accordance with Section [01 35 21 - LEED Requirements] [01 74 19 - Waste Management and Disposal].
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION



Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM C260, "Air Entrainment Admixtures for Concrete,"
 - .2 ASTM A641/A641M-19, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .3 ASTM A775/A775M-19, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - .4 ASTM A884/A884M-19 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
 - .5 ASTM A1064/A1064M - 18a Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - .6 ASTM C920-18 Standard Specification for Elastomeric Joint Sealants.
 - .7 ASTM D1751-18, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types).
- .2 CSA Group (CSA)
 - .1 CSA-A23.1-14 /A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .2 CAN/CSA A23.3-19, Design of Concrete Structures
 - .3 CAN/CSA-A3000-18, Cementitious Materials Compendium (consists of A3001, A3002, A3003, A3004 and A3005).
 - .4 CAN/CSA-G30.18-09(R2019), Carbon-Steel Bars for Concrete Reinforcement.
- .3 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2019 – Alberta Edition.
- .4 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC-2018, Manual of Standard Practice.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and additives and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS Safety Data Sheet (SDS) in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 00 - Hazardous Materials.
 - .1 Submit 2 copies of WHMIS SDS.

- .3 Provide inspection and testing results reports for review by the Department Representative and do not proceed without written approval when deviations from mix design or parameters found.
- .4 Concrete hauling time: provide for review by The Department Representative deviations exceeding maximum allowable time of 90 minutes for concrete delivered to site of Work and discharged after batching.
- .5 Sustainable Design Submittals:
 - .1 Recycled Content:
 - .1 When Supplementary Cementing Materials (SCMs) are used, provide evidence to certify reduction in portland cement from Base Mix to Actual SCMs Mix, as percentage.
- .6 Quality Assurance Submittals:
 - .1 Submit in accordance with Section 01 45 00 - Quality Control
 - .2 Mill Test Report: upon request, submit to the Department Representative a certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .3 At least 4 weeks prior to beginning Work, inform of source of fly ash.
 - .1 Changing source of fly ash without written approval of Department Representative is prohibited.

1.3 QUALITY ASSURANCE

- .1 Provide to the Department Representative, 4 weeks minimum prior to starting concrete work, valid and recognized certificate from plant delivering concrete.
- .2 Quality Control Plan: provide written report to the Department Representative verifying compliance concrete in place meets performance requirements.
- .3 Testing shall conform to CAN/CSA-A23.2.

1.4 INSPECTION AND TESTING

- .1 Notify Department Representative at least 48 business hours before complete formwork and concrete reinforcement will be ready for inspection.
- .2 Allow ample time for inspection and corrective work, if required, before scheduling concrete placement.
- .3 Concrete sampling, inspection and testing is to be performed by an Inspection and Testing Firm appointed and paid by the Owner.
- .4 Provide free access to all portions of work and cooperate with appointed firm.
- .5 Submit proposed mix design of each class of concrete to Department Representative and Inspection and Testing Firm for review prior to commencement of work.
- .6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.
- .7 Notify Inspection and Testing Firm before placing concrete, in ample time to permit scheduling.

- .8 Three concrete test cylinders will be taken for every 75m³ or less of each class of concrete placed.
- .9 At least three test cylinders will be taken daily for each class of concrete placed. Record shall include atmospheric and concrete temperatures.
- .10 One additional test cylinder will be taken during cold weather concreting, and be cured on job site under same conditions as concrete it represents.
- .11 One slump test and one air content test will be taken for each set of test cylinders taken.
- .12 Additional slump tests may be taken as necessary to verify quality of concrete.
- .13 Testing of concrete will be performed in accordance with CAN/CSA A23.2. Test results will be issued to Contractor, Department Representative.
- .14 Pay costs for retesting required due to defective materials or workmanship.
- .15 Contractor may arrange and pay for additional tests for use as evidence to expedite construction.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Concrete hauling time: deliver to site of Work and discharged within 90 minutes maximum after batching.
 - .1 Modifying maximum time limit without receipt of prior written agreement from The Department Representative and concrete producer as described in CSA A23.1/A23.2 is prohibited.
 - .2 Deviations submitted for review by the Department Representative.
- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .3 Packaging Waste Management: in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 AMBIENT CONDITIONS

- .1 Placing concrete during rain or weather events damaging to concrete is prohibited.
- .2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/A23.2.
- .3 Cold weather protection:
 - .1 Maintain protection equipment, in readiness on Site.
 - .2 Use such equipment when ambient temperature below 10°C, or when temperature may fall below 10°C before concrete cured.
 - .3 Placing concrete upon or against surface at temperature below 10°C is prohibited.
- .4 Hot weather protection:
 - .1 Protect concrete from direct sunlight when ambient temperature above 27°C.
 - .2 Prevent forms of getting too hot before concrete placed. Apply accepted methods of cooling not to affect concrete adversely.

- .5 Protect from drying.

Part 2 Products

2.1 DESIGN CRITERIA

- .1 Alternative 2 - Prescription: to CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.
- .2 To CSA A23.3-19 Design of Concrete Structures

2.2 PERFORMANCE CRITERIA

- .1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established by The Department Representative and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.

2.3 MATERIALS

- .1 Portland Cement: GU unless noted otherwise in drawings.
- .2 Supplementary cementing materials: with minimum [30] % F fly ash replacement, by mass of total cementitious materials to CAN/CSA A3001.
- .3 Admixture:
 - .1 Chemical to ASTM C494/C494M, including:
 - .1 High Range Water Reducing Admixture.
 - .2 Others as specified in drawings
 - .2 Air Entrainment to ASTM C260
- .4 Fine Aggregate: conforming to Normal Density Fine Aggregate, CAN/CSA A23.1.
- .5 Coarse Aggregate: conforming to Normal Density Coarse Aggregate, CAN/CSA A23.1, Group I, 20 - 5mm.
- .6 Coarse Aggregate for Toppings: conforming to Normal Density Coarse Aggregate, CAN/CSA A23.1 M, Group I, 14 - 5mm.
- .7 Aggregate: Ensure that no aggregates are used which may undergo volume change due to alkali reactivity, moisture retention or other causes. Confirm suitability of aggregate with a petrographic analysis if deemed necessary by the Department Representative.
- .8 Water: clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material conforming to CSA A23.1/A23.2.
- .9 Reinforcing bars:
 - .1 Billet steel, grade 400, deformed bars to CSA G30.18, unless indicated otherwise.
- .10 Welded steel wire fabric:
 - .1 Plain in accordance ASTM A1064/A1064M, fabricated from as drawn steel wire into flat sheets; sizes as indicated on Drawings.
 - .2 Finish:

- .1 Galvanized: [Hot dip galvanized after welding] [Fabricated from galvanized wire] having Class A coating in accordance with ASTM A1064/A1064M.
- .11 Materials specified in Section 03 10 00 Concrete Forming and Accessories.
- .12 Other concrete materials: to CSA A23.1/A23.2.

2.4 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete: N/A
- .2 Alternative 2 - Prescriptive Method for specifying concrete: owner's concrete mix in accordance with CSA A23.1/A23.2.
 - .1 Ensure materials used in concrete mix have been submitted for testing and meet requirements of CSA A23.1/A23.2.
 - .2 Concrete supplier to proportion concrete mix for normal or HVSCM including:
 - .1 Cement type: GU unless noted otherwise in Structural Drawings
 - .2 Minimum compressive strength at 28 days age:
 - .1 Interior slab-on-grade: 25 MPa
 - .2 Interior Beam and Column: 35 MPa
 - .3 Exterior slab-on-grade: 35 MPa
 - .4 Concrete piles, pile caps, grade beams: 35 MPa
 - .3 Class of exposure:
 - .1 Interior slab-on-grade: N
 - .2 Interior Beam and Column: N
 - .3 Exterior slab-on-grade: C-1
 - .4 Concrete piles, pile caps, grade beams: F-1
 - .4 C-1 concrete to have <1500 coulombs within 91 days chloride ion penetrability required as per Table 2 in CSA A23.1.
 - .5 Intended application: As noted in Structural Drawings.
 - .6 Admixture:
 - .1 Chemical to ASTM C494/C494M, including:
 - .1 High Range Water Reducing Admixture.
 - .2 Air Entrainment to ASTM C260
 - .7 Supplementary cementing materials: with minimum 30 % Type F fly ash replacement, by kg/m³ of total cementitious material.
 - .8 Aggregate: Normal-density, maximum size 20mm.
 - .9 Maximum water/cement ratio: 0.45 unless noted otherwise
 - .10 Air content category: 1 per Table 4 of CSA A23.1.
 - .11 Use accelerating admixtures in cold weather only when approved by Department Representative. If approved, use of admixtures will not relax cold weather placement and curing requirements. Do not use calcium chloride.

- .12 Use set retarding admixture during hot weather only when approved by Department Representative.
- .13 All admixtures are subject to the approval of the Department Representative. List all proposed admixtures in mix design submission. Do not change or add admixtures to approved design mixes without Department Representative's approval.

Part 3 Execution

3.1 EXAMINATION

- .1 Before starting this work, examine work done by others which affects this work.
- .2 Notify the Department Representative of any conditions which would prejudice proper completion of this work.
- .3 Commencement of work implies acceptance of existing conditions.

3.2 PREPARATION

- .1 Provide The Department Representative 48 hours notice before each concrete pour.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Concrete delivery and handling to facilitate placing with minimum of rehandling, and without damage to existing structure or Work.
- .4 Protect previous Work from staining.
- .5 Clean and remove stains prior to application of concrete finishes.

3.3 INSTALLATION/APPLICATION

- .1 Do cast-in-place concrete work in accordance with CSA A23.1/A23.2.
- .2 Sleeves and inserts:
 - .1 Cast in sleeves, ties, slots, anchors, reinforcement, frames, conduit, bolts, waterstops, joint fillers and other inserts required built-in.
 - .2 Sleeves and openings minimum 100 mm x 100 mm not indicated, reviewed by The Department Representative.
- .3 Handling equipment shall be kept free from hardened concrete or foreign material and cleaned at frequent intervals.
- .4 Ensure all anchors, seats, plates and other items to be cast into concrete are securely placed and will not interfere with concrete placement.
- .5 Maintain accurate records of cast in place concrete items. Record date, location of pour, quantity, air temperature and test samples taken.
- .6 Ensure reinforcement, inserts, embedded parts, formed expansion and control joints and are not disturbed during concrete placement.

- .7 Prepare set concrete by removing all laitance and loose materials and applying bonding agent. Apply bonding agent in accordance with manufacturer's recommendations.
- .8 Place concrete continuously between present construction and control joints.
- .9 Vibrate concrete using the appropriate size equipment as placing proceeds in strict accordance with CAN/CSA-A23.1. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure.
- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels and pack solidly with approved non shrink grout.
- .11 Do not place concrete if carbon dioxide producing equipment has been in operation in the building during the 6 hours preceding the pour. This equipment shall not be used during placing or for 12 hours after placing. During placing and curing concrete, surfaces shall be protected by formwork or an impermeable membrane from direct exposure to carbon dioxide, combustion gases or drying from heaters.
- .12 Honeycomb or embedded debris in concrete is not acceptable.
- .13 Remove and replace defective concrete.

3.4 FINISHES

- .1 Formed surfaces exposed to view in accordance with Architectural and Owner requirements and in accordance with Clause 7.6 of CSA A23.1.
- .2 Interior floor slabs to be left exposed or to receive [epoxy], or other covering requiring a smooth surface: initial finishing operations followed by final finishing comprising mechanical floating and steel trowelling in accordance with CSA A23.1/A23.2 Table 21 to produce hard, smooth, dense steel trowelled surface free from blemishes; finish classification Class C – “Very Flat”.
- .3 Interior concrete to receive tile: wood float or broom finish, level and true to a tolerance of 3 mm in 2.4 m in walls and 3 mm in 3 m for floors and in accordance with CSA A23.1/A23.2 Table 21, finish classification Class C.
- .4 Hardened floor finish: Liqui-Hard Ultra Molecular Concrete Densifier and Chemical Hardener by W.R. Meadows in strict accordance with Manufacturer’s instructions where specified in Architectural drawings.
- .5 Floor slabs to receive mortar bed for tile: screed to correct grade and provide broomed texture unless specified otherwise by.
- .6 Equipment pads: provide smooth trowelled surface.
- .7 Pavements, walks, curbs and exposed site concrete:
 - .1 Screed to plane surfaces and use [magnesium] [wood] [aluminum] floats.
 - .2 Provide round edges and joint spacings using standard tools.
 - .3 Trowel smooth and provide lightly brushed non-slip finish.

3.5 CONTROL JOINTS

- .1 Cut control joints in slabs on at maximum grade at locations indicated, to CSA A23.1/A23.2 and install specified joint sealer/filler.

3.6 EXPANSION AND ISOLATION JOINTS

- .1 Install premoulded joint filler in expansion and isolation joints full depth of slab flush with finished surface to CSA A23.1/A23.2.
- .2 Fill all expansion joints with a two-component polyurea sealant meeting the formulation and performance characteristics of Blome Sealant 73 as manufactured by Blome International, O'Fallon, MO (800) 886-3455. Install in accordance with the latest Blome Sealant 73 data sheet and good industry practice.

3.7 CURING

- .1 Use curing compounds compatible with applied finish on concrete surfaces free of bonding agents and to CSA A23.1/A23.2.
- .2 Cure concrete surfaces in accordance with CSA A23.1/A23.2, Clause 7.7 Table 19, curing type depending on concrete type, application and weather, and Appendix D.
 - .1 Unless noted otherwise by concrete finish supplier, conform to curing type 3 where concrete is shown to receive liquid hardener, paint, ceramic tile, quarry tile, terrazzo and toppings.
- .3 Curing shall meet requirements specified for each concrete finish.
- .4 Submit curing plan to the Department Representative upon request.

3.8 SEALING APPLICATION

- .1 As specified in Architectural, Structural drawings or by the Owner.

3.9 SITE TOLERANCES

- .1 Concrete floor slab finishing tolerance to CSA A23.1/A23.2.

3.10 DEFECTIVE CONCRETE

- .1 Concrete not meeting the requirements of the Specifications and Drawings shall be considered defective concrete.
- .2 Concrete not conforming to the lines, detail and grade specified herein or as shown on the Drawings shall be modified or replaced at the Contractor's expense and to the satisfaction of the Department Representative. Finished lines, dimensions and surfaces shall be correct and true within tolerances specified herein and in the Formwork Section of these Specifications.
- .3 Concrete not properly placed resulting in excessive honeycombing, and all honeycombing and other defects in critical areas of stress shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Department Representative.
- .4 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When five or more tests of the same class of concrete are available, the average of any five consecutive tests shall be equal to, or greater than the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. If any of the criteria of the above clause are not met, the Department Representative shall have the right to require one or more of the following:

- .5 Changes in mix proportions for the remainder of the work.
- .6 Cores drilled and tested from the areas in question as directed by the Department Representative and in accordance with CAN/CSA-A23.2. The test results shall be indicative of the strength of the in-place concrete.
- .7 Load testing of the structural elements. The changes in the mix proportions and the testing shall be at the Contractor's expense.
- .8 Concrete failing to meet the strength requirements of this specification shall be strengthened or replaced at the Contractor's expense and the satisfaction of the Department Representative .

3.11 FIELD QUALITY CONTROL

- .1 Concrete testing: to CSA A23.1/A23.2 by testing laboratory designated and paid for by the Owner.

3.12 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate cleaning area for tools to limit water use and runoff.
- .4 Cleaning of concrete equipment in accordance with Section 01 35 43 Environmental Procedures.
- .5 Waste Management: in accordance with 01 74 19 - Waste Management and Disposal.
 - .1 Disposal of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location posing health or environmental hazard is prohibited.

END OF SECTION



PART 1 GENERAL

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-25.20-95, Surface Sealer for Floors.
- .2 CSA International
 - .1 CAN/CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction//Methods of Test for Concrete.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for concrete finishes and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements or 01 35 43 - Environmental Procedures. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content in g/L.
 - .2 Include application instructions for concrete floor treatments.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 PERFORMANCE REQUIREMENTS

- .1 Product quality and quality of work in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

2.2 SEALING COMPOUNDS

- .1 Surface sealer: to CAN/CGSB-25.20, Type 1 - solvent-based, clear.
- .2 Sealants: maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .3 Surface sealer: acrylic carnuba wax.
- .4 Surface sealers are not manufactured or formulated with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium and their compounds.

2.3 CURING COMPOUNDS

- .1 Select water-based, curing compounds.

2.4 MIXES

- .1 Mixing ratios in accordance with manufacturer's written instructions.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that slab surfaces are ready to receive work and elevations are as indicated on shop drawings.

3.2 PREPARATION OF EXISTING SLAB

- .1 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radiused edges unless otherwise indicated.
- .2 Saw cut control joints to CAN/CSA-A23.1, 24 hours maximum after placing of concrete.
- .3 Use mechanical stripping to remove chlorinated rubber or existing surface coatings.
- .4 Use protective clothing, eye protection and respiratory equipment during stripping of chlorinated rubber or existing surface coatings.

3.3 APPLICATION

- .1 Apply concrete finishing floor hardener in accordance with manufacturer's written instructions.
- .2 After floor treatment is dry, seal control joints and joints at junction with vertical surfaces with sealant.
- .3 Apply floor treatment in accordance with Sealer manufacturer's written instructions.
- .4 Clean over spray. Clean sealant from adjacent surfaces.

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 finished installation in accordance with manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 National Research Council Canada (NRCC)
 - .1 Alberta Building Code (ABC)
 - .2 National Building Code (NBC)
 - .3 National Energy Code of Canada (NECB)

1.2 DEFINED TERMS

- .1 The definitions of this section are not meant to supersede definitions of the Building Code, Standards, or Contract Documents and apply only to these Contract Documents.
- .2 *As-built Drawing or Document* means a document that reflects the installed, fabricated, constructed, or commissioned condition of an item or project based on information provided by another party and not verified by the professional engineer.
- .3 *As Indicated* means the item is to be as specified or shown as per the drawings.
- .4 *Contract Documents* means all documents including the engineering and architectural drawings and specifications as defined in the construction contracts for constructing the building.
- .5 *Deferred Work* means work which the Owner, Departmental Representative, and Contractor agree, or out of necessity, simply cannot be completed in a timely manner and is therefore excluded from the calculation in determining whether *substantial performance* of a contract has been reached.
- .6 *Deficient Work* means work that has been performed, but performed incorrectly or to an inadequate standard, not performed as specified, or damaged prior to turnover to the Owner.
- .7 *Equipment Start-up* means work that is performed by the Contractor in conjunction with the equipment Manufacturer to get the systems ready for *commissioning or testing*.
- .8 *Furnish* means supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- .9 *Incomplete Work* means work specified in the *Contract Documents* that has not been performed or completed.
- .10 *Install* means unloading, temporary storage, unpacking, assembly, erecting, placing, anchoring, applying working to dimension, finishing curing, protecting, cleaning, and similar operations.
- .11 *Operation and Maintenance Manual* means a collection of information containing all necessary technical information on building systems for the building owner/user to carry out maintenance and operation.
- .12 *Provide* means to furnish and install, complete and ready for the intended use.
- .13 *Ready for Use for the Purpose Intended* means the system or equipment is safe, code compliant, functionally complete, and ready to be turned over to the building Owner. The

specific definition of *ready for use for the purpose intended* is project specific and is the discretion of the Departmental Representative.

- .14 *Record Drawing or Document* means a professional document prepared by a professional engineer to record design changes to an initial design for which he or she has accepted responsibility and which represents the final design of the project. Typically issued or retained as verification that on-site conditions are in accordance with the final design.
- .15 *Samples* means physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.
- .16 *Seasonal Testing* means testing of equipment and systems that have been functionally tested during winter or summer conditions and require retesting during the opposite conditions.
- .17 *Shop Drawings* means drawings, diagrams, illustrations, schedules, performance charts, brochures, product data, and other data specifically prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate details of portions of the work. *Shop Drawings* do not form part of the Contract Documents.
- .18 *Submittals* means items required by the *Contract Documents* to be submitted by the Contractor, such as requests for payment, progress reports, *Shop Drawings*, manufacturer's literature on equipment, reports, schedules. *Submittals* are normally used by the registered professional of record to aid in ascertaining whether the work substantially complies in all material respects with the plans and supporting documents prepared by the registered professional of record.
- .19 *Testing* means work that is performed by the Contractor during installation to prove the quality and workmanship before the equipment or systems are put "on-line".
- .20 *Warranty Work* means completed work that requires completion after the date of a substantial performance and is discovered prior to expiry of the contract warranty period.
- .21 *Work* means any activity, duty or function defined by the *Contract Documents*, the Alberta Building Code, work carried out on or about the construction site or on, in or about a building.

1.3 ABBREVIATIONS

- .1 AABC – Associated Air Balance Council
- .2 ABC – Alberta Building Code
- .3 AHU – Air Handling Unit
- .4 ANSI – American National Standards Institute
- .5 ASTM – American Society for Testing of Materials
- .6 ASHRAE – American Society of Heating Refrigeration and Air Conditioning Engineers
- .7 ASME – American Society of Mechanical Engineers
- .8 BAS – Building Automation System
- .9 CEMA – Canadian Electrical Manufacturers Association
- .10 CGA – Canadian Gas Association

- .11 CGSB – Canadian General Standards Board
- .12 CSA – Canadian Standards Association
- .13 FM – Factory Mutual Engineering Corporation
- .14 HVAC – Heating, Ventilation, and Air Conditioning
- .15 IAO – Insurer's Advisory Organization of Canada
- .16 MERV – Minimum Efficiency Reporting Value
- .17 NECB – Model National Energy Code for Buildings
- .18 NBC – National Building Code
- .19 NC – Noise Criteria
- .20 NFPA – National Fire Protection Association
- .21 NEMA – National Electrical Manufacturers Association
- .22 OH&S – Occupational Health and Safety
- .23 PPE – Personal Protective Equipment
- .24 RC – Room Criteria (for noise measurement)
- .25 SMACNA – Sheet Metal and Air Conditioning Contractors National Association
- .26 ULC – Underwriter's Laboratory of Canada

1.4 INTENT

- .1 This Section specifies the common requirements for the work of Divisions 20 through 25 supplemented by the requirements of Division 01.
- .2 Mechanical Division Contract Documents
 - .1 The mechanical Division Contract Documents shall be read in conjunction with the manufacturer's installation instructions.
 - .2 The Mechanical Contract Documents are copyright and may not be reproduced without the explicit written permission of SNC-Lavalin.
- .3 Mechanical Drawings
 - .1 The mechanical drawings are not detailed installation instructions and do not show every pipe or duct elbow, fitting, valve, or system component required by the specifications or show the exact required routing of the services unless specifically indicated.
 - .2 The intended purpose of the mechanical drawings is to show, graphically, quantities and locations of tagged equipment, and how the products interface with other materials and products.
 - .3 The mechanical drawings are diagrammatic and only approximately to scale even when scales are indicated. Do not scale from the mechanical drawings in order to determine dimensions or distances.
- .4 Mechanical Specifications

- .1 The intent of the mechanical specifications is to define the quality and types of materials and workmanship upon which the contract is based.
- .2 The mechanical specifications shall be read in conjunction with the mechanical drawings.
- .3 Where codes or standards are referenced in the mechanical specifications, conform to the date or version of the code or standards referenced by the national building code in effect at the time of the submission of bids unless a specific date or edition is referenced.
- .5 Contract Document Discrepancies
 - .1 Review the entire set of Contract Documents (i.e. drawings and specifications of all Divisions) prior to bidding on the work.
 - .2 Where a specific requirement is identified in any portion of the Contract Documents (plan drawing, specifications, equipment schedules, details, sections, schematics, etc.) it shall be considered as a requirement of the Contract Documents regardless of whether it appears, or is represented consistently elsewhere in the Contract Documents.
 - .3 Where a discrepancy exists between portions of the Contract Documents:
 - .1 Submit a written request for clarification during the tendering phase.
 - .2 If a written request for clarification is not received by the Departmental Representative, or if there is insufficient time for the Departmental Representative to provide a written clarification of the design intent by means of an Addendum, include the cost for BOTH requirements inclusive of all affected trades. Do not choose to carry the cost of one interpretation over the other.
 - .3 The Departmental Representative reserves the right to clarify the design intent once a discrepancy within the Contractor Documents has been identified at no additional cost to the Owner.
 - .4 Work that has taken place relating to the discrepancy without first requesting clarification of the design intent is subject to removal and replacement at no additional cost to the Owner.
 - .5 A credit shall be provided for work or equipment deemed to be unnecessary after the design intent is confirmed by the Departmental Representative.
- .6 Delegated Design Responsibilities to the Contractor
 - .1 Where design responsibilities are specifically delegated to the Contractor in the Contract Documents:
 - .1 The services shall be provided by a proper licensed professional.
 - .2 Documents shall bear such professional's written approval when submitted to the Departmental Representative.
 - .3 The Owner and Departmental Representative shall be entitled to rely on the adequacy, accuracy, and completeness of the services, certifications, or approvals performed or provided by such design professionals.
 - .4 The licensed designer's signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by the Designer.

1.5 SUSTAINABILITY REQUIREMENTS

- .1 All equipment shall meet the mandatory requirements of the National Energy Code for Buildings (NECB).

1.6 GENERAL SAMPLE REQUIREMENTS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Label each sample indicating their intended use
 - .3 Indicate any deviations from the Contract Documents
- .2 Submittal Procedure
 - .1 Submit one (1) sample to the Departmental Representative at the time of Shop Drawing review or as required.
- .3 Required Samples
 - .1 Refer to the requirements of each Section.
- .4 Acceptance Criteria
 - .1 A sample shall be considered approved upon written indication by the Departmental Representative.

1.7 GENERAL MOCK-UP REQUIREMENTS

- .1 Scope of Work
 - .1 Provide mock-ups where required by each Section.
 - .2 The approved mock-up will serve as the standard of workmanship and material that against which the work will be verified.
- .2 Review Procedure
 - .1 Prepare the mock-up to include all applicable systems that could potentially affect the acceptance of the work
 - .2 Coordinate with other trades as required to incorporate information that could potentially affect the acceptance of the work
 - .3 Make arrangements with the Departmental Representative to review the work
 - .4 Obtain approval from the Departmental Representative to proceed with Construction based on the quality of work demonstrated in the mock-up
- .3 Mock-Up Documentation
 - .1 Provide a written record of the mock-up review.
 - .2 Submit in accordance with the requirements of Division 01.
 - .3 File Format: Portable document format (PDF) file.
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date mock-up was demonstrated to the Departmental Representative
 - .2 Name of people present at the demonstration

- .2 Technical Information
 - .1 Written description of the contents of the mock-up including specific construction details
 - .2 Photographs demonstration the construction details
- .4 Submittal Procedure
 - .1 Submit one (1) complete copy to the Departmental Representative for review no later than ten (10) working days after Departmental Representative review of mock-up.
 - .2 Include a copy of the mock-up review in the Operation and Maintenance Manuals.
- .5 Acceptance Criteria
 - .1 The mock-up shall be considered the accepted basis of construction upon the Departmental Representative's written acceptance.

1.8 GENERAL INFORMATION DOCUMENT REQUIREMENTS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date the document was issued
 - .2 Name of company responsible for issuing the document including contact information for associated personnel
 - .3 Purpose of the document
 - .4 Other general information pertinent to the understanding of the document
 - .2 Technical Information
 - .1 As required based on the nature of the document
- .2 Submittal Procedure
 - .1 Submit one (1) complete copy to the Departmental Representative for review at the time of Shop Drawing submittal.
 - .2 Include a copy of the report in the Operation and Maintenance Manuals.
- .3 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.9 GENERAL SHOP DRAWING REQUIREMENTS

- .1 The Contractor's Responsibility with Respect to Shop Drawings

- .1 The Contractor shall be solely responsible for ensuring that all product information contained in the Shop Drawing is completely compliant with the Contract Documents prior to submitting to submitting for the Departmental Representative's review.
 - .1 The Contractor shall be responsible for correcting all products or materials found to be non-compliant with the requirements of the Contract Documents at such time they are discovered.
- .2 The Contractor shall thoroughly review all Shop Drawings including those prepared by Subcontractor's, Sub-Subcontractor's, and Engineers retained by the Contractor to ensure:
 - .1 Their formatting is compliant with the Contract Document requirements
 - .2 The product information is compliant with the Contract Documents
 - .3 The materials and equipment are constructible
 - .4 Any deviances in parameters (such as dimensions, weight, electrical characteristics, performance parameters, etc.) with respect to the basis of design equipment indicated in the Drawing Schedules or specifications will not result in additional costs to other trades.
 - .5 They have been coordinated and verified that the components fit and work together in accordance with the design intent
- .3 Where professional design services or certifications are delegated to a responsible design professional retained by the Contractor, the properly licensed responsible design professional's signature and seal shall appear on all related Shop Drawings.
- .4 Contract Document Deviance Summary
 - .1 Should it be impossible for the Contractor, a Subcontractor, or a Supplier to provide products and materials that are compliant with the requirements of the Contract Documents, the Contractor shall prepare a Contract Document Deviance Summary Sheet and attach it to the front page of the Shop Drawing submittal.
 - .2 The Contract Document Deviance Summary shall include:
 - .1 An explanation of why it is not possible to the meet the requirements of the Contract Documents with evidence supporting this claim (i.e. a letter or correspondence from the base-specified equipment supplier, etc.).
 - .2 A list of specific performance parameters/functionality that cannot be met.
 - .3 A summary of the Contractor's recommended substitute products or materials.
 - .4 A written description of all pertinent changes, deviations or substitutions from the requirements of the Contract Documents.
 - .5 The Shop Drawing for the Contractor's recommended alternate product or material (from an Approved Manufacturer when possible) that best matches the performance criteria for the specified equipment that otherwise meets the requirements of the Contract Documents.

- .6 A list of other deviations from the Contract Documents that will result of using the alternate material or equipment including, but not limited to:
 - .1 Space requirements
 - .2 Equipment weights
 - .3 Electrical parameters
 - .4 Control or functionality
- .7 Indication as to whether the alternate product or material will have a cost implication (including that of other trades which may be affected)
 - .1 Where the alternate product is deemed to affect the cost of the work (as either a credit or an extra), the Contractor shall prepare a quotation identifying the cost impact (including all affected trades) and include it in the Shop Drawing submission.
- .2 The Departmental Representative's review of the Shop Drawings
 - .1 The purpose of the Departmental Representative's review of the Shop Drawings is to:
 - .1 Provide a secondary review of the information provided by the Contractor to check if the specified closeout submittal requirements are met (i.e. format, type of content, maintenance requirements, etc.)
 - .2 Review supplemental information about the products and materials being provided by the Contractor to assist the Departmental Representative in performing their Field Reviews.
 - .2 The Departmental Representative's review of the Shop Drawings is not:
 - .1 An indication that the Shop Drawing has been reviewed by the Departmental Representative for compliance with the Contract Documents.
 - .2 An indication that deviances of product parameters such as dimensions, quantities, weight, electrical characteristics, performance parameters, etc. are acceptable and will not result in additional costs to other trades.
 - .3 The Departmental Representative's review of Shop Drawings that have been stamped as 'Reviewed', or 'Reviewed as Noted', that contain deviations from the Contract Document requirements, regardless of whether they were accompanied by the Contractor's Contract Document Deviance Summary, shall not be deemed as an acknowledgement or approval of the deviation.
 - .4 The Departmental Representative's review of Shop Drawings produced by a licensed professional retained by the Contractor shall be for the purpose of checking for general conformance with the design parameters provided for the purpose of defining the Design Delegate's scope of work and responsibilities in the Contract Documents.
 - .5 Departmental Representative's Shop Drawing Comments
 - .1 Shop Drawings submitted for the Departmental Representative's review will be stamped using one of the four responses below and returned to the Contractor:

- .1 Reviewed
 - .2 Reviewed as Noted
 - .3 Revise and Submitted
 - .4 Not Reviewed
 - .2 Shop Drawings marked as 'Reviewed' indicate that the Departmental Representative has reviewed the information provided, but not necessarily that the information is in accordance with the Contract Documents which is the sole responsibility of the Contractor.
 - .3 Shop Drawings marked as 'Reviewed as Noted' indicate that the Departmental Representative has reviewed the information provided, but not necessarily that the information is in accordance with the Contract Documents which is the sole responsibility of the Contractor. Shop Drawing marked as 'Reviewed as Noted' do not need to be resubmitted and are noted only to provide general comments to the Contractor such as reminders of related information contained in the Contract Documents such as site coordination that needs to take place and other general information that is not expected to affect the project cost.
 - .4 Shop Drawings marked as 'Revise and Resubmit' indicate that the Departmental Representative happened to notice information that was not compliant with the requirements of the Contract Documents and therefore must be revised and resubmitted.
 - .5 Shop Drawings marked as 'Not Reviewed' indicate that the Departmental Representative (or specific Sub-Departmental Representative) does not need to review the information.
 - .6 The Contractor shall not perform any portion of the work for which Shop Drawings, mock-ups, samples or similar product data submittals are required until the respective submittal has been stamped by the Departmental Representative as either 'Reviewed' or "Reviewed as Noted".
 - .7 Where the Departmental Representative's review of the shop drawing or Contract Document Deviance Summary results in the need to revise the Contract Documents, the Departmental Representative shall issue a written Change Order.
 - .1 If the Contractor believes that a comment made by the Departmental Representative on a shop drawing marked as 'Reviewed as Noted' will result in additional costs, the Contractor shall notify the Departmental Representative immediately.
- .3 Submittal Format
- .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

- .5 Each Shop Drawing submittal shall include a cover sheet prepared by the submitting Contractor that MUST include the following:
 - .1 Project Name
 - .2 Departmental Representative's Project Number
 - .3 Descriptive title of the Shop Drawing
 - .4 Contractor's Shop Drawing tracking number
 - .5 Number of pages under title page
 - .6 Brief description of Shop Drawing contents (including equipment tags that match those shown on the drawings)
 - .7 Specification Section number relating to the Shop Drawing
 - .8 Name and phone number of Contractor or Sub-Contractor responsible for ensuring that the information contained in the Shop Drawing is compliant with the Contract Documents
 - .9 Name and phone number of the equipment supplier responsible for the technical details of the Shop Drawing who may be contacted by Departmental Representative to discuss the submittal details (Providing this information may prevent the need for a Shop Drawing to be stamped as 'Revise and Resubmit')
 - .10 Contractor's stamp, signed by Contractor's authorized representative certifying review and approval of submissions, verification of field measurements and compliance with Contract Documents
 - .11 A blank area no smaller than 200 mm wide x 125 mm high for exclusive use by Departmental Representative for stamps and review comments
- .6 Shop Drawings shall include the following general information as a minimum in addition to that required by individual Sections:
 - .1 Associated equipment tag and functional descriptor
 - .2 Installation instructions
 - .3 Manufacturer certification of current model production
 - .4 Certification of compliance to applicable codes and standards
 - .5 Required operating and maintenance clearances
 - .6 Detailed drawings of bases, supports, and anchor bolts
 - .7 Performance based on specified set-point parameters
 - .8 Electrical information including (but not limited to): voltage, phase, frequency, full-load amps, horsepower, current, and power factors.
 - .9 Weight and dimensions
- .4 Submittal Procedure
 - .1 Submit one (1) copy of each Shop Drawing to the Departmental Representative as required by each Section and for all tagged equipment on the drawings and specifications.
 - .2 Thoroughly review the content of each Shop Drawing and stamp it to indicate it is compliant with the Contract Documents prior to submission to the Departmental Representative. The Contractor's stamp indicates they have

verified it is in strict accordance with the requirements of the Contract Documents.

- .3 Shop Drawings that are not submitted according to the Submittal Procedure, or not in accordance with the Submittal Format, are subject to being returned without review by Departmental Representative. Shop Drawings that are rejected due to a failure to comply with the specification requirements shall be resubmitted allowing the full fifteen (15) working day review period from the date of the re-submittal.
 - .1 The Contractor shall be responsible for submitting Shop Drawings in accordance with the specification requirements in order to not adversely affect the Construction Schedule.
- .4 Where the Departmental Representative has stamped Shop Drawings as 'Revise and Resubmit', make the required changes and/or provide the requested information and resubmit.
 - .1 Allow an additional ten (10) working days (as a minimum) for the Departmental Representative to do a review of the Revise and Resubmit Shop Drawings.
 - .2 Allow sufficient time in the Construction Schedule for Shop Drawing review including sufficient time for subsequent reviews of Shop Drawings that have been noted as "Revise and Resubmit".
- .5 Departmental Representative's Timely Review of Shop Drawings
 - .1 Allow a minimum of ten (10) working days between the date of submission to the Departmental Representative and the requested return date for the Departmental Representative's review.
 - .1 Shop Drawings that indicate a desired return date less than the minimum specified review duration may not be achievable and shall not be considered a construction delay caused by the Departmental Representative if the target return date is not met.
 - .2 Refrain from submitting a large amount of Shop Drawings over a short period of time or in large groups. If this occurs, the Departmental Representative reserves the right to indicate the required amount of time in order to do a proper review of the Shop Drawings. Adequate time for the Departmental Representative to do a thorough review of the Shop Drawings shall be allowed for in the construction schedule and extensions to the review period shall not be deemed as an unforeseen extension to the construction schedule.

1.10 GENERAL TEST REPORT REQUIREMENTS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information

- .1 Date the test was performed
 - .2 Name of company performing the test including contact information for associated personnel
 - .3 Purpose of the test
 - .4 Information on equipment used for the test including records of equipment calibration
 - .5 Other general information pertinent to the understanding of the test
- .2 Technical Information
 - .1 As required based on the nature of the test
- .2 Submittal Procedure
 - .1 Submit one (1) complete copy to the Departmental Representative for review no later than ten (10) working days after testing.
 - .2 Include a copy of the report in the Operation and Maintenance Manuals.
- .3 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.11 GENERAL MANUFACTURER'S EQUIPMENT START-UP REPORT REQUIREMENTS

- .1 General Requirements
 - .1 Provide a report issued by the equipment manufacturer (or authorized representative) providing a record that the equipment has been set up properly, checked for safety, and is ready to be put into operation.
 - .2 Coordinate timing of manufacturer's equipment start-up with the work of other trades.
- .2 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date the equipment set-up was performed
 - .2 Name of company performing the work and contact information for associated personnel
 - .2 Technical Information
 - .1 Content and organization in accordance with the manufacturer's standards
- .3 Submittal Procedure

- .1 Submit one (1) complete copy to the Departmental Representative for review no later than ten (10) working days after equipment setup.
- .2 Include a copy of the manufacturer's equipment start up report in the Operation and Maintenance Manuals.
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.12 GENERAL CERTIFICATION REPORT REQUIREMENTS

- .1 General Requirements
 - .1 Provide a report issued by the recognized authority certifying the specified parameters or code requirements have been met.
- .2 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date the system was reviewed by the certifying agent
 - .2 Name of company of the certifying agent and contact information for associated personnel
 - .2 Technical Information
 - .1 Description of the specific requirements that need to be met for certification
 - .2 Signature of the certifying agent stating the system is compliant with the project or code requirements
- .3 Submittal Procedure
 - .1 Submit one (1) complete copy to the Departmental Representative for review no later than ten (10) working days after review of the certifying agent.
 - .2 Include a copy of the certification report in the Operation and Maintenance Manuals.
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.13 GENERAL OPERATION AND MAINTENANCE MANUAL REQUIREMENTS

- .1 General Requirements
 - .1 The work of Divisions 20 through 24 shall be incorporated into the Operation and Maintenance Manual requirements of this Section.

- .1 The Operation and Maintenance Manual shall be separate from the EMCS Operation and Maintenance Manual required by Section 25 05 01 – EMCS General Requirements.
 - .2 Submit Operation and Maintenance Manuals three times throughout the duration of the project in accordance with Submittal Format below.
 - .2 Submittal Format
 - .1 Submittal Content Requirements
 - .1 Submittal #1: Format Review
 - .1 Submittal Format: Indexed .pdf file
 - .2 Submittal Timeline: Submit after all information of Section 1 – Mechanical Systems has been prepared (see General Manual Format)
 - .3 Submittal Instructions: Provide placeholders for all other information not included in this submittal
 - .4 Required information:
 - .1 All formatting including cover text for each binder, wording of each tab, and directories
 - .2 All information required by Section 1 – Overview
 - .2 Submittal #2: Pre-TAB Review
 - .1 Submittal Format: Indexed .pdf file
 - .2 Submittal Timeline: Submit a minimum of 15 working days prior to commencement of TAB
 - .3 Submittal Instructions:
 - .1 Information required by any Section may be submitted at this time providing that it is complete
 - .4 Required information:
 - .1 All information from Submittal #1
 - .2 All information required by Section #2
 - .3 All information required by Section #3
 - .3 Submittal #3: Final Submission Review
 - .1 Submittal Format: Indexed .pdf file and one (1) physical copy
 - .2 Submittal Timeline: Submit after acceptance of Substantial Performance
 - .3 Submittal Instructions:
 - .1 Ensure the cover text for each binder has been approved prior to preparing the physical copies
 - .4 Required information:
 - .1 Provide all information required by this Section
 - .2 Physical Copy Assembly Requirements
 - .1 Prepare using 8-1/2 x 11 inch text pages, expanding post binders with durable green-colour cloth covers connected to spine with piano hinges.

- .2 Prepare binder cover with printed title "OPERATION AND MAINTENANCE MANUAL – MECHANICAL", title of project, and subject matter of binder when multiple binders are required.
- .3 Internally subdivide the binder contents with permanent page dividers, logically organized as described in the format Section below; with tab titling clearly printed on reinforced laminated plastic tabs.
- .4 Provide additional binders as required to store all of the required information.
- .3 General Manual Format
 - .1 Section 1 - Overview
 - .1 Index:
 - .1 Complete O&M Manual index (for all mechanical binders)
 - .2 Include this tab at the beginning of each binder when multiple binders are used
 - .2 Directory:
 - .1 Directory listing names, addresses, and telephone numbers the Departmental Representative, all Sub-Departmental Representatives, Contractors, Subcontractors, and all equipment suppliers
 - .3 Drawings:
 - .1 List of all mechanical Contract Document Drawings
 - .2 List of all drawings produced by Design Delegates (i.e. Fire Protection Engineer, etc.)
 - .4 Description of Systems:
 - .1 Written description for each major mechanical system related to the scope of work (site services, plumbing, heating, cooling, HVAC, fire protection. controls etc.)
 - .5 Identification:
 - .1 Systems and Equipment Identification Directory required by Section 20 15 43 – Mechanical Identification
 - .2 Valve Tag Directory required by Section 20 15 43 – Mechanical Identification
 - .2 Section 2 – Tests & Reports
 - .1 Permits:
 - .1 All permits obtained for the project
 - .2 All permit inspection reports
 - .2 Manufacturer’s Equipment Start-Up Reports:
 - .1 All Manufacturer’s Equipment Start-Up Reports required by each Section
 - .3 System Test Reports:
 - .1 All System Test Reports required by each Section.
 - .4 Testing Adjusting & Balancing Reports:

- .1 All TAB reports required by Section 20 30 01 – Testing, Adjusting, and Balancing
 - .2 Final operational set-points for field-adjustable devices (other than equipment controlled through the BMS)
 - .5 Commissioning Reports:
 - .1 Documentation required by Section 20 30 03 – Mechanical System Commissioning
 - .6 Certificates
 - .1 Declaration of Extended Warranties (where required by each Section)
 - .2 Declaration of Premium Motor Efficiencies required by Section 20 10 13 – Common Motor Requirements
 - .3 Declaration of Motor/VFD Compatibility and Warranty as required by Section 20 10 14 – Variable Speed Drives
 - .4 Seismic Hazard Review as required by Section 20 15 10 – Seismic Controls
 - .5 Seismic Engineer Assurance of Field Review and Compliance as required by Section 20 15 10 – Seismic Controls
 - .6 Fire Protection Engineer Assurance of Field Review and Compliance as required by Section 21 05 05 – Common Work Results – Fire Suppression
 - .7 Certificate of Compliance from Medical Gas Certifier
 - .8 Certificate of Compliance from the Clean Room/Fume Hood/BSC Certifier
 - .9 All ABSA Submittal Documentation required by Section 23 22 13 – Steam and Condensate Piping
- .3 Section 3 – Product Data
 - .1 Shop Drawings:
 - .1 All Shop Drawings and product data as required by each Section (separate each product with an indexed tab)
 - .2 Maintenance Data:
 - .1 Installation instructions
 - .2 Servicing, maintenance, operation, and trouble-shooting instructions for each Shop Drawing as appropriate
 - .3 Detailed schedule and description of preventive maintenance and lubrication tasks organized by the following categories: Daily, Weekly, Monthly, Semi-annually and Annually and including the tools required
 - .4 Descriptive text that provides instruction on actions to be taken in event of equipment failure
 - .5 Recommended spare parts
 - .6 Spare Parts Delivery Transmittal as required by this Section

- .3 System Demonstration and Training:
 - .1 System Demonstration and Training Report for mechanical systems
- .3 Submittal Procedure
 - .1 Submit Operation and Maintenance Manuals (O&Ms) three times throughout the project as follows:
 - .1 Submittal #1: Format Review
 - .2 Submittal #2: Pre-TAB Review
 - .3 Submittal #3: Final Submission Review
 - .2 Include all content from previous review submittals, including required revisions in subsequent review submittals.
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.14 CONTRACTOR MARKED-UP AS-BUILT DOCUMENT REQUIREMENTS

- .1 General Requirements
 - .1 Provide Contractor marked-up As-Built Drawings for **ALL** Contract Document drawings including those prepared by Design Delegate professionals (when present).
 - .1 Submit a copy of each drawing in the Contractor As-Built Document Submittal even if that drawing does not contain Contractor mark-ups.
 - .2 Contractor As-Built Documents shall be submitted separately from the EMCS Contractor As-Built Documents required by Section 25 05 01 – EMCS General Requirements.
 - .3 Accessibility
 - .1 Contractor Marked-up As-Built Drawings shall be available to the Departmental Representative for review at all times throughout Construction.
 - .4 Format during Construction
 - .1 Contractor Marked Up As-Built Drawings may be maintained in either hard-copy or digital format during construction but must be submitted digitally in accordance with the Submittal Format requirements below.
 - .5 Accuracy
 - .1 Maintain a complete set of Contractor As-Built Documents from the beginning of the Work through to its completion updating them daily as a minimum.
 - .2 Store Contractor As-Built Documents separate from other documents being used for construction.
 - .3 Incorporate all changes and variances to the Contract Documents including:
 - .1 Contractor initiated changes due to site coordination
 - .2 Addenda

- .3 Change Orders
- .4 Site Instructions
- .5 Instructions though Requests for Information
- .6 Shop Drawing comments
- .7 Product substitutions or alternates that deviate from the equipment schedules
- .8 Sample and Mock-up comments
- .9 Existing systems that are affected by demolition or renovation work
- .10 Changes made as required by Manufacturer's installation instructions
- .11 Changes made as part of Testing, Adjusting, and Balancing
- .12 Changes made as part of System Start-up
- .13 Changes made as part of System Commissioning
- .6 Specific Information Required
 - .1 Ensure the following specific information is clearly indicated on the Contractor As-Built Drawings:
 - .1 Measured horizontal and vertical dimensions for all underground service mains referenced to grid lines (including where services leave the building perimeter).
 - .2 All information relating to concealed conditions
 - .3 Field changes of dimension and detail
 - .4 Pertinent installation details not shown in the Contract Document Drawings
 - .5 Updated Contractor Drawing equipment schedules showing installed product details and parameters (manufacturer, model, performance parameters, capacity, etc.) data differs from the base specification shown on the Drawings
 - .6 Other specific As-Built requirements specified throughout Divisions 20 through 24
 - .7 Location of:
 - .1 Access door locations and sizes
- .2 Submittal Format
 - .1 Contractor As-Built Documents shall be submitted in PDF format.
 - .2 Note entries in red text and deletions in blue.
 - .3 Ensure entries are clear and legible, complete, and accurate.
 - .1 Contractor As-Built Drawings shall not contain notes or other markings that are not indicative of as-built conditions.
 - .4 The Contractor shall mark each As-Built Drawing with a stamp in the bottom right hand corner, or in the title block, that reads, "AS-BUILT DRAWINGS AS RECORDED BY THE CONTRACTOR" (Signature of Contractor) (date) or equivalent text that indicates that the Contractor has incorporated all required information into the drawing set

.3 Submittal Procedure

- .1 Upon request by the Contractor, the Departmental Representative will provide a full set of the Contract Document Drawings (excluding the drawings produced by the Fire Protection Engineer or other drawings prepared by the Contractor) in .PDF format for the Contractor's use in preparing the marked-up As-Built Drawings
- .2 After the Work has been completed and after the deficiencies have been corrected and signed-off as complete, the Contractor shall sign and date each As-Built Drawing (including those where no changes have occurred)
- .3 Scan the entire set of marked-up As-Built Drawings in .PDF format and submit to the Departmental Representative for review.
 - .1 Marked-up As-Built Drawings that are submitted in an alternate format, are missing required information, are incomplete, or that do not bear the Contractor's signature and date indicating accuracy of the information, are subject to be rejected and declared incomplete.
 - .2 Incorporate comments made by the Departmental Representative and resubmit for additional review as requested
- .4 Include a copy of the original Contractor marked-up As-Built Drawings in the Operation and Maintenance Manuals

.4 Acceptance Criteria

- .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.15 GENERAL SPARE PARTS REQUIREMENTS

.1 General Requirements

- .1 Prepare a Spare Parts Delivery Transmittal that identifying all of the spare parts required by each Section
- .2 Provide beside each spare part line item a signature field for the Contractor and the Owner
- .3 Submit Spare Parts in advance of Substantial Completion

.2 Submittal Format

- .1 Submit in accordance with the requirements of Division 01.

.3 Submittal Procedure

- .1 After delivery of Spare Parts, the Contractor and the Owner's Representative shall both sign the Transmittal to indicate delivery and acceptance of the materials
- .2 Provide quantities of Spare Parts in accordance with the requirements of each Section.
- .3 Submit one (1) completed copy of the Spare Parts Delivery Transmittal to the Departmental Representative in advance of Substantial Completion.
- .4 Insert one (1) completed copy of the Spare Parts Delivery Transmittal in the Operation and Maintenance Manuals in advance of Operation and Maintenance Manuals Review Submittal.

.4 Acceptance Criteria

- .1 The delivery of Spare Parts shall be considered complete upon submitting a Spare Parts Delivery Transmittal that has been signed by both the Contractor and Owner's Representative.

1.16 GENERAL SYSTEM DEMONSTRATION AND TRAINING REQUIREMENTS

.1 General Requirements

- .1 Provide System Demonstration and Training Report in accordance with Division 01 supplemented by the requirements of this Section
- .2 Refer to Section 20 30 03 – Mechanical Commissioning for additional System Demonstration and Training requirements

.2 Scope

- .1 Provide system demonstration and training for each item of equipment and system including start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance

.3 Quality Assurance

- .1 Provide competent instructors thoroughly familiar with the system for which demonstration and training are being provided.
- .2 Provide training sessions that are project specific.

.4 Timing

- .1 Arrange for System Demonstration and Training after:
 - .1 Equipment and systems are fully operational and have been tested, adjusted, and balanced
 - .2 All sequences of operation have been verified by the Contractor to be functioning in accordance with the Contract Documents for each mode of operation
- .2 System Demonstration and Training may be performed over the course of multiple days as required based on the amount of work required and availability of those involved.
 - .1 Where System Demonstration and Training is completed in multiple sessions, a System Demonstration and Training Report shall be provided for each session

.5 Materials

- .1 Supply all necessary tools, equipment and personnel to facilitate complete system demonstration
- .2 Provide visual and audio equipment aids as required to perform training.
- .3 Provide each trainee with a copy of the System Demonstration and Training Plan at the start of the session as an agenda.
 - .1 Coordinate the number of trainees that will be attending in advance of training.

.6 Execution

- .1 The training sessions shall follow the outline in the Table of Contents of the Operation and Maintenance Manual and refer to the location of the information in the Manual for reference.
- .2 System Demonstration and Training shall start with classroom-like sessions followed by hands-on training for each piece of equipment.
 - .1 Provide any pertinent equipment to facilitate the session including overhead projectors, slides, and video/audio material.
- .3 If the equipment or system should fail to operate in accordance with the Contract Documents during the training session, the nature of the failure shall be noted in the System Demonstration and Training Report and the session shall be rescheduled after the issue(s) have been corrected if determined to be necessary by the Owner
- .4 The Contractor shall determine the appropriate trade, manufacturer's representative, or combination of people who shall run each session.
 - .1 When a Commissioning Authority is present on the project, the Contractor shall coordinate with them to determine who will lead the System Demonstration and Training sessions
- .5 Where the Contractor has used systems to maintain an environment at the worksite during the construction process, include lessons learned and information gathered on the operations of the systems
- .6 Training topics shall include:
 - .1 A review of the written Operation and Maintenance Manuals with an emphasis on the safe and proper operating requirements, preventative maintenance, and special tools needed and spare parts inventory suggestions.
 - .2 Demonstration of start-up and operation of equipment (in all control modes), shut-down, seasonal changeover procedures and emergency procedures
 - .3 Discussion of relevant health and safety issues and concerns
 - .4 Discussion of warranties, guarantees, and emergency contact information
 - .5 Common troubleshooting problems and solutions
 - .6 Discussion of any peculiarities of equipment installation or operation

1.17 SUBSTANTIAL COMPLETION

- .1 General Requirements
 - .1 The substantial completion requirements of this Section apply to the Work of Divisions 20 through 25.
 - .2 The substantial completion requirements of this Section shall supplement and be read in conjunction with the substantial completion requirements of Section 20 00 01 – Common Work Results – Mechanical and Division 1.
 - .3 The substantial completion requirements of this section are not intended to identify every specific requirement for Substantial Completion, but rather to provide the Contractor with the general criteria that will be used to evaluate whether the work is substantially complete.

- .1 The Departmental Representative reserves the right to identify additional specific criteria for substantial completion based on the nature of the project and the risks to the Owner.
 - .2 The Contractor shall be responsible for requesting clarification of any additional substantial completion requirements in advance of the Application for Substantial Completion to ensure if there are any other specific requirements in terms of completed work before applying for Substantial Completion.
 - .2 Application for Substantial Completion
 - .1 When the Contractor is of the opinion that the Work of sections 20 through 25 meets the requirements for Substantial Completion as defined by this Section and elsewhere in the Contract Documents, the Contractor shall prepare and submit to the Departmental Representative the following:
 - .1 A statement indicating the Contractor's belief that the state of the Work meets the substantial performance requirements of this Section
 - .2 A list of *Deficient Work*, as previously identified by the Departmental Representative, that is yet to be corrected along with a schedule of when the corrective work will take place
 - .3 A list of proposed *Deferred Work* along with a schedule of when the *Deferred Work* will take place
 - .4 A list of *Incomplete Work*
 - .2 Acceptance of the Contractor's list of *Deficient Work*, *Deferred Work*, and *Incomplete Work* shall not alter the requirements of the Contract Documents or be misconstrued as the Departmental Representative's acceptance that work not identified is accepted as complete or in accordance with the Contract Documents.
 - .3 The Contractor shall allow a minimum of 10 working days after the Application for Substantial Completion for the Departmental Representative to review the application documents against the substantial completion requirements, perform a final field review of the work, and to prepare a written response for the Application.
 - .1 If rejection of the Application for Substantial Completion could negatively impact pre-determined occupancy, partial occupancy, or other scheduled dates that are critical to the Contractor or Owner, the Contractor shall be responsible for incorporating additional time into the construction schedule to allow for a proper Substantial Completion application and review process based on the complexity of the work and importance of the project deadlines.
 - .3 The work shall be considered Substantially Complete when all of the following general and specific requirements have been met:
 - .1 General requirements:
 - .1 The products of the work are *Ready for the Purpose Intended* as determined by the Departmental Representative.
 - .2 *Deficient Work* is minor (in the opinion of the Departmental Representative) and may be corrected safely and with minimal disruption to building operations and occupants after the work is turned over.

- .3 *Deferred Work* (including post-occupancy TAB and/or commissioning) has been identified by the Contractor in writing and collectively agreed to be treated as such by the Owner, Departmental Representative, and Contractor.
- .4 There is no *Incomplete Work* in the opinion of the Departmental Representative.
- .5 Substantial Completion requirements identified in other specification Sections have been satisfied.
- .6 The Departmental Representative has indicated in writing that the work is deemed to be substantially complete.
- .2 Specific Requirements for Substantial Completion
 - .1 As a minimum, the following must be complete prior to application for Substantial Completion
 - .1 All work relating to building code requirements is complete and all related closeout documents have been submitted and accepted as complete by the Departmental Representative.
 - .2 All work relating to life-safety is complete and all related closeout documents have been submitted and accepted as complete by the Departmental Representative.
 - .3 All work relating to start-up, testing, adjusting, and balancing is complete and all related closeout documents have been submitted and accepted as complete by the Departmental Representative.
 - .4 All work relating to commissioning is complete and all related closeout documents have been submitted and accepted as complete by the Departmental Representative.
 - .5 All Contractor Marked-Up As-Built Document Requirements have been submitted and accepted as complete by the Departmental Representative.
 - .6 The Final Submission Review of the Operation and Maintenance Manuals has been submitted and accepted as complete by the Departmental Representative.

1.18 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment required in Division 20 through Division 24 Sections

1.19 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Certification Reports
 - .1 Contractor's Declaration of Warranty
 - .2 Information Documents

- .1 System Demonstration and Training Plan
- .2 System Demonstration and Training Report
- .3 Record of Service Work
- .3 Operation and Maintenance Manuals Content
 - .1 Operation and Maintenance Manuals requirements where specified in Division 20 through Division 24 Sections
- .4 Contractor As-Built Markups Content
 - .1 Contractor As-Built Markup requirements where specified in Division 20 through Division 24 Sections
- .5 Spare Parts
 - .1 Spare parts requirements where specified in Division 20 through Division 24 Sections

1.20 CONTRACTOR'S DECLARATION OF WARRANTY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Division 0 supplemented by the requirements of this Section.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a signed statement indicating full warranty for the Work and equipment provided by the Contractor and the Contractor's Sub-Contractors in accordance with the warranty requirements specified in Division 0 or a required by the specifications of Divisions 20 through 25.
 - .2 Submittal Format
 - .1 Include the following:
 - .1 Approved date of Substantial Performance
 - .2 Description of all work and equipment covered by the warranty
 - .3 Warranty end date
 - .4 Name of the Contractor Company carrying the warranty
 - .5 Name and signature of the Contractor's employee having authority to warranty the work
 - .6 Where Extended Warranties are required, provide a clear description of the applicable systems or equipment the Extended Warranty applies to
 - .3 Submittal Procedure
 - .1 Include a copy of all Declaration of Warranties in the Operation and Maintenance Manual.

1.21 SYSTEM DEMONSTRATION AND TRAINING PLAN

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.

- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a written plan describing the details of the System Demonstration and Training execution.
 - .2 Submittal Format
 - .1 Organize the System Demonstration and Training Plan as follows:
 - .1 Desired date of training (coordinated by the Contractor with other training activities)
 - .2 Training Agenda: Detailed list of topics that will be discussed during training session(s)
 - .3 Sample sign-in sheet
 - .4 List of visual/audio aids that will be used for training
 - .5 Names of training personnel
 - .6 Description of representative Owner staff from facilities who should be present for the training
 - .3 Submittal Procedure
 - .1 Submit one (1) copy to the Departmental Representative for review a minimum of fifteen (15) working days prior to the first planned training session date.
 - .2 Schedule System Demonstration and Training during regular work hours or at alternate times approved by the Owner
 - .3 Make any revisions to the System Demonstration and Training Plan as required by the Departmental Representative or the Owner for resubmission prior to performing system demonstration and training.

1.22 SYSTEM DEMONSTRATION AND TRAINING REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a report showing that System Demonstration and Training has been completed satisfactorily to the Owner.
 - .2 Submittal Format
 - .1 Organize the System Demonstration and Training Plan as follows:
 - .1 The format and training agenda shall be in accordance with the HVAC Commissioning Process, ASHRAE Guideline 1-1989R, 1996 are an equivalent standard
 - .2 The date and time the training took place
 - .3 Name of training personnel
 - .4 The agenda for the training session updated to include any other important topics discussed

- .5 A copy of the sign-in sheet indicating each person who was present (including the Owner, Contractor, and Commissioning Lead representatives as applicable)
 - .6 A list of any materials that have (or will be) turned over to the Owner to supplement the training session (videos, literature, etc.)
 - .7 Lessons learned and information gathered on the operations of the systems used to maintain an environment at the worksite during the construction phase
 - .8 Any supplemental information requested to be inserted into the Operation and Maintenance Manuals during the session
 - .9 A statement prepared by the Contractor, signed by both the Contractor and Owner, indicating that the training session has been satisfactorily completed
- .3 Submittal Procedure
- .1 Submit one (1) copy to the Departmental Representative for review no later than ten (10) working days after the date of each training session.
 - .2 Insert one (1) complete copy of the final System and Demonstration and Training Report in the Operation and Maintenance Manuals.
- .3 Acceptance Criteria:
- .1 System Demonstration and Training shall be considered complete upon submission of the signed statement of completion signed by the Owner for each of the training sessions indicated in the System Demonstration and Training Plan.

1.23 RECORD OF SERVICE WORK

- .1 Specific Requirements
- .1 Scope of Work
 - .1 Provide a record of service work for each service call request made during the warranty period.
 - .2 Submittal Format
 - .1 Each time service work is performed, record the following:
 - .1 Date and time service call request was made by the Owner
 - .2 Date and time service call was first responded to by the service company
 - .3 Name of Service Company and personnel assigned to the service call
 - .4 Description of the system behavior prompting a service call request
 - .5 Description of the specific equipment or components requiring maintenance
 - .6 Description of the work required to be performed to resolve the service request
 - .7 Summary of material and time spent required to resolve the service request

- .8 Time and date of service call completion
- .3 Submittal Procedure
 - .1 Consolidate all Records of Service Work one month before the end of the warranty period and provide to the Owner for inclusion in the Operations and Maintenance Manual

Part 2 Products

2.1 ACCESS DOORS

- .1 In general, access doors are not typically indicated on the mechanical drawings due to potential variances with the installed equipment locations and those shown on the drawings.
 - .1 Provide access doors in accordance with this Section and where required for equipment access, in addition to the locations shown on the drawings.
- .2 Indicate the locations of all access doors on the Contractor marked-up As-Built Drawings.
- .3 Sizes
 - .1 Except where otherwise indicated, the minimum sizes shall be as follows:
 - .1 For body entry: 600 x 600 mm.
 - .2 For hand entry: 300 x 300 mm.
- .4 Construction
 - .1 Rounded safety corners (except fire rated doors), concealed hinges, screwdriver latch, anchor straps, and able to open 180 degrees
 - .2 Fire rating: ULC listed to suit wall or ceiling assembly
 - .3 Security access doors: construction per standard doors except with tamper-proof security cam latches using allen head with center-pin. Provide where indicated
- .5 Materials
 - .1 Standard access doors
 - .1 300x300 mm size: 16ga door, 18ga frame
 - .2 600x600 mm size: 14ga door, 16ga frame
 - .2 Fire-rated access doors:
 - .1 Material construction as per ULC listing
 - .3 Security access doors:
 - .1 12ga door, 12ga frame
- .6 Finish
 - .1 Tiled or marble surfaces and other special areas: Stainless steel with brushed satin or polished finish as directed by Departmental Representative.
 - .2 Wet areas: aluminum or stainless steel construction (areas such as showers, PCC decontamination etc.).
 - .3 All other areas: Prime coated baked enamel steel.

Execution

3.1 EQUIPMENT ACCESS

- .1 Access for Maintenance
 - .1 Coordinate the timing of the work with other trades to ensure that the minimum required maintenance space (for servicing, lubrication, disassembly, and removal of equipment or components) is maintained.
 - .1 The Contractor shall be responsible for remedial work required where the work of one Sub-Contractor infringes on the required access space for equipment due to inadequate coordination or planning
 - .2 The required access area for maintenance shall be the greater value between the minimum dimensions recommended by the manufacturer, dimensions indicated on the drawings, or dimensions required by the specifications.
 - .1 Regardless of published minimum requirements for maintenance access, coordinate and install the systems so that equipment can be maintained in a safe manner.
 - .2 The Departmental Representative (along with the Owner's representative) reserves the right to determine if equipment can be maintained in a safe manner.
- .2 Access Doors
 - .1 Supply and install access doors for all concealed mechanical equipment requiring maintenance (supplemented by locations shown on the plan drawings) to suit site conditions to enable access for operating, inspecting, adjusting, and servicing.
 - .2 Access doors are not required in lay-in tile ceilings. Provide Above-Ceiling Equipment Markers in accordance with Section 20 15 43 – Mechanical Identification.
 - .3 Ensure that equipment requiring maintenance is clearly within view and is easily reachable for operating, inspecting, adjusting, and servicing without the need for special tools or removal of obstructing equipment.

3.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store, and handle materials in accordance with the manufacturer's requirements, and that of Division 01.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with the manufacturer's recommendations in clean, dry, well-ventilated area
 - .2 Store and protect materials from nicks, scratches, and blemishes
 - .3 Replace defective or damaged materials with new

3.3 PAINTING

- .1 Provide painting in accordance with the requirements of Division 09.

- .2 Apply a minimum of one coat of corrosion resistant primer paint to all ferrous supports and site fabricated equipment.
- .3 Provide system identification in accordance with the requirements of Section 20 15 43 – Mechanical Identification.

3.4 REPAIRS AND RESTORATION

- .1 Restore finishes that have been damaged throughout the course of construction to new condition.

3.5 CLEANLINESS

- .1 Clean the construction site daily in accordance with the requirements of Division 01.
- .2 Cleanliness During Construction:
 - .1 Clean concealed areas (i.e. above ceiling spaces) as required to maintain dust-free surfaces on equipment and services
 - .2 Refer to Section 23 31 13 – Ductwork for special requirements for duct cleanliness
- .3 Final Cleaning:
 - .1 Clean the exterior surfaces of all equipment
 - .2 Clean the interior surfaces of all equipment with maintenance access doors or panels
 - .3 Replace all filters with new media
 - .4 Clean all strainers in piped systems

3.6 WASTE MANAGEMENT

- .1 Remove, store, or reuse construction waste in accordance with the requirements of Division 01.

3.7 ELECTRICAL WORK

- .1 Provide electrical work in accordance with the requirements of Division 26 supplemented by the requirements of each Section.
- .2 All control wiring to conform to the requirements of Division 26 including conduit, wiring and connections below 50 V that are related to control systems specified in Division 25 and/or shown on mechanical drawings.
- .3 Refer to Division 26 for the quality of materials and workmanship requirements.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA)
 - .1 CSA Z317.13, Infection Control During Construction, Renovation, and Maintenance of Healthcare Facilities

1.2 GENERAL REQUIREMENTS

- .1 Perform demolition and renovation work in accordance with this Section and the requirements of Division 01 and Division 02.
- .2 Cease work and notify the Departmental Representative and Owner immediately if hazardous materials are discovered during the work (other than those previously identified).
- .3 Take precautions to protect existing equipment from being damaged
 - .1 The Contractor shall be responsible for remedial work to repair damage caused to existing equipment to remain.
- .4 Where demolition is required, completely remove all associated materials and equipment including piping, ducting, wiring, tubing, supports, controls, etc. unless indicated otherwise.
- .5 Confirm piping is completely drained prior to demolition.

1.3 HANDLING OF DEMOLISHED MATERIALS IDENTIFIED FOR REUSE OR TURN-OVER TO THE OWNER

- .1 Where materials or equipment have been identified for reuse, carefully remove, store, and protect them in accordance with the requirements of Division 01.
- .2 Where materials or equipment have been identified for turn-over to the Owner, carefully remove them, and turn over to the Owner in accordance with the requirements of Division 01.
- .3 The pressure differential between the construction areas and adjacent areas shall be maintained as negative throughout the course of construction.

1.4 RENOVATION WORK IN AN OCCUPIED OR PARTIALLY OCCUPIED BUILDING

- .1 The boundary of the mechanical renovation work is not necessarily limited to the general area of renovations identified by a zone boundary on the plan drawings.
 - .1 Affected services may pass through occupied areas outside of the renovation zone boundary including on floors above or below the general renovation area, or where the source equipment is located.
- .2 Where mechanical systems serve other occupied areas of the building that need to remain operational during the work, provide a Service Interruption Strategy Report.

1.5 PHASED RENOVATIONS OF MECHANICAL SYSTEMS

- .1 Perform phased renovations of mechanical systems in accordance with the phasing requirements of Division 01.
- .2 The Contractor shall bear and include all costs associated with the safe execution of the phased work without adversely affecting the operation or environmental conditions of other occupied areas of the building. These costs may include provision of temporary services not explicitly defined in the Contract Documents, system by-passes, temporary equipment, or other work required in order to execute the work.

1.6 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Existing Condition Site Survey
 - .2 Service Interruption Strategy Report

1.7 EXISTING CONDITION SITE SURVEY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Conduct a site review of the existing mechanical equipment to identify any variances between actual conditions and information shown on the drawings illustrating existing systems
 - .2 Submittal Format
 - .1 Mark up a copy of the drawings or provide a list of all deviations or conditions that will affect the cost of the work for the work specified
 - .2 Provide supplemental drawings, sketches, or pictures to illustrate the conditions

1.8 SERVICE INTERRUPTION STRATEGY REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
 - .2 Do not shut down any mechanical services until approved by the Owner or the Authority Having Jurisdiction (for life-safety services).
 - .1 Coordinate service shut-downs with the Owner each time prior to completing the work
 - .3 Coordinate the Service Interruption Strategy for all life safety systems with the Departmental Representative, the Fire Protection Engineer, and the Authority Having Jurisdiction.
- .2 Specific Requirements

- .1 Scope of Work
 - .1 Where demolition work is required in an occupied or partially occupied building and the work affects the services of these spaces, provide a detailed overview of the strategy proposed for ensuring continuous operation of non-renovated areas during temporary service shut-downs.
- .2 Submittal Format
 - .1 Indicate the following:
 - .1 A description of the systems which will be affected by the work
 - .2 Strategies for maintaining service of mechanical systems to areas outside of the renovation boundary (i.e. isolation valves that will be closed, temporary services required, etc.)
 - .3 The planned /requested date(s) of the shut-down
 - .4 The expected duration the system or service will be shut-down
 - .5 Identify any unknown factors that may pose a risk for being able to provide continuous service for occupied areas
 - .6 Where phased renovations are required, provide strategies for each phase
 - .7 Valve tag numbers of isolation valves that are required to be closed during the service shut-down
 - .8 Measures that will be taken to ensure the safety of the building occupants during the shut-down period
- .3 Submittal Procedure
 - .1 Revise the proposed strategies as required to suit the requirements of the Owner.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Provide all materials and equipment as required to perform the work of this Section.

Part 3 Execution

3.1 SELECTIVE DEMOLITION IN OCCUPIED BUILDINGS

- .1 Perform demolition in occupied (or partially occupied) buildings in accordance with the requirements of Division 01.
- .2 Strictly follow the Owner's standards and guidelines for construction and demolition in an occupied when provided.
- .3 Remove, store, or reuse construction waste in accordance with Division 01.

3.2 WORK SCHEDULE

- .1 Perform work during times in accordance with the requirements of Division 01 and Division 02.

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- .2 Work may be suspended at any time at the Owner's Representative discretion due to safety issues or work adversely affecting the occupied areas of the building.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings
- .2 Canadian Standards Association (CSA)
 - .1 CSA C390, Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-Phase Induction Motors
- .3 Consortium for Energy Efficiency (CEE)
 - .1 Premium Efficiency Motor Standards
- .4 Institute of Electrical and Electronics Engineers Standards Association (IEEE)
 - .1 IEEE 112, Standard Test Procedure for Polyphase Induction Motors and Generators
- .5 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG-1, Motors and Generators
- .6 National Fire Protection Agency (NFPA)
 - .1 NFPA 70, National Electric Code

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Manufacturer's Certification of Motor Efficiency

1.3 MANUFACTURER'S CERTIFICATION OF MOTOR EFFICIENCY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a signed declaration from the motor or equipment manufacturer indicating efficiency for each motor.
 - .2 Submittal Format
 - .1 Signature of compliance for each motor

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:

- .1 Operation and Maintenance Manuals Content
- .2 Contractor As-Built Markups Content
- .3 Spare Parts

1.5 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.6 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of motors (to the side, under, over fan)

1.7 SPARE PARTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Provide spare parts for this Section as follows:
 - .1 Motor belts: One (1) set of belts for each belt-driven motor.

Part 2 Products

2.1 MOTORS – GENERAL CONSTRUCTION AND REQUIREMENTS

- .1 Efficiency
 - .1 All permanently wired polyphase motors serving the building shall have a nominal full-load motor efficiency equal to or exceeding the minimum requirement CSA C390, Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-Phase Induction Motors.
 - .2 All electric motors manufacturer alone or as a component of another piece of equipment shall meet or exceed the minimum motor efficiency requirements indicated in ASHRAE 90.1 2016 – Energy Standard for Buildings Except Low-Rise Buildings.
- .2 Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.

.3 Electrical Service:

- .1 Confirm motor size, voltage and phase with Division 26
- .4 Visible Nameplate: Stamped stainless steel indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- .5 Wiring Terminations:
 - .1 Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized in accordance with NFPA 70, National Electric Code, threaded for conduit
 - .2 For fractional horsepower motors where connection is made directly, provide conduit connection in end frame
- .6 Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

2.2 MOTORS - SINGLE PHASE POWER

- .1 General: speed as indicated, continuous duty, built-in overload protection, and resilient mount.
- .2 Open Drip-proof or Enclosed Air Over Enclosure: Class A insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.
- .3 Multiple-Speed: through tapped windings.

2.3 MOTORS - THREE PHASE POWER – UP TO 3 HP

- .1 Type: TEFC, Premium efficiency to meet or exceed the requirements of ASHRAE 90.1.
- .2 Starting Torque, Starting Current, Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- .3 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- .4 Insulation System: NEMA Class B.
- .5 Inverter Duty: All motors connected to variable speed drives to be Inverter Duty rated and shall be wound using spike resistant magnet wire rated to 1600V.
- .6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- .7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- .8 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 50,000 hours when connected to drive belts; 150,000 hours for direct coupled applications. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- .9 Sound Power Levels: To NEMA MG 1.

- .10 Weatherproof Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- .11 Nominal Efficiency: To meet referenced ASHRAE 90.1 standards at full load and rated voltage when tested to IEEE 112.
- .12 Nominal Power Factor: To meet referenced ASHRAE 90.1 at full load and rated voltage when tested to IEEE 112.
- .13 Provide motors for mechanical equipment as specified.

2.4 MOTORS - THREE PHASE POWER –OVER 3HP

- .1 Type: TEFC, Premium efficiency to meet or exceed Consortium for Energy Efficiency (CEE) Premium Efficiency full load efficiencies.
- .2 Starting Torque, Starting Current, Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- .3 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors. All motors over 50 HP to be complete with internal shaft ground ring.
- .4 Insulation System: NEMA Class F.
- .5 Inverter Duty: All motors connected to variable speed drives to be Inverter Duty rated and shall be wound using spike resistant magnet wire rated to 1600V.
- .6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- .7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- .8 Thermistor System (Motor Sizes 50 HP and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
- .9 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 50,000 hours when connected to drive belts; 150,000 hours for direct coupled applications. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- .10 Sound Power Levels: To NEMA MG 1.
- .11 Weatherproof Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- .12 Nominal Efficiency: To meet referenced CEE standards at full load and rated voltage when tested to IEEE 112.
- .13 Nominal Power Factor: To meet referenced CEE at full load and rated voltage when tested to IEEE 112.
- .14 Provide motors for mechanical equipment as specified.

2.5 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.6 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to steel frame
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms
 - .3 38mm diameter holes on both shaft centres for insertion of tachometer
 - .4 Removable for servicing
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel
 - .2 Securely fasten in place
 - .3 Removable for servicing
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh
 - .2 Net free area of guard: not less than 80% of fan openings
 - .3 Securely fasten in place
 - .4 Removable for servicing

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

3.3 COMMISSIONING - MOTORS

- .1 Refer to Section 20 30 03 – Mechanical System Commissioning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
 - .3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture
 - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices
- .4 National Research Council Canada (NRCC)
 - .1 National Plumbing Code of Canada (NPC)
- .5 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
 - .1 Seismic Restraint Manual, Guidelines for Mechanical Systems including Addenda

1.2 DESIGN REQUIREMENTS

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning in accordance with MSS SP58.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.4 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 01 – Common Work Results – Mechanical indicate the following:
 - .1 Any applicable load calculations

1.5 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.6 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.7 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of:
 - .1 Housekeeping pads (including dimensions)
 - .2 Floor-mounted structural supports for overhead pipe/equipment racks

Part 2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with the following:
 - .1 MSS SP58
 - .2 ANSI B31.1
 - .3 SMACNA Seismic Restraint Manual

- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports unless otherwise noted: Galvanized, zinc-plated, cadmium-plated, or prime plated
 - .2 Ensure steel hangers in contact with copper piping are copper-plated or epoxy coated
- .2 Upper attachment structural:
 - .1 To SMACNA Seismic Restraint Manual
- .3 Upper attachment to concrete:
 - .1 To SMACNA Seismic Restraint Manual
- .4 Shop and field-fabricated assemblies:
 - .1 To SMACNA Seismic Restraint Manual
- .5 Hanger rods: threaded rod material to MSS SP58 and SMACNA Seismic Restraint Manual:
 - .1 Ensure that hanger rods are subject to tensile loading only
- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized
 - .2 Attachments for copper piping: copper plated black steel
 - .3 Use insulation shields for pipework
 - .4 Oversize pipe hangers and supports
- .7 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: cadmium plated or prime plated
 - .2 Finishes for copper, glass, brass or aluminum pipe work: black, with formed portion plastic coated
- .10 Pipe rollers
 - .1 Finish: Malleable iron or cast iron
 - .2 Material: Cast iron roll and roll stand with carbon steel rod to MSS SP69
 - .3 Refer to 20 20 30 – Piping and Equipment Insulation for shield or saddle requirements

2.3 INSULATION PROTECTION SHIELDS

- .1 Refer to 20 20 30 – Piping and Equipment Insulation for requirements on insulated piping.

2.4 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.

2.5 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 2springs 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.

2.6 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Division 05.
- .2 Submit calculations with shop drawings.

2.7 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

- .1 Provide templates to ensure accurate location of anchor bolts.

2.8 HOUSE-KEEPING PADS

- .1 Base-mounted Equipment: Provide 150 mm high concrete housekeeping pads, 150 mm larger all around than equipment and with chamfer pad edges.
- .2 Concrete: to Division 03.
- .3 Anchor housekeeping pads to building structure in accordance with SMACNA Seismic Restraint Manual when seismic restraints are required by 20 00 01 - Common Work Results for Mechanical.

2.9 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Division 05.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with the manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated
- .3 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .5 Use approved constant support type hangers where:
 - .1 Vertical movement of pipe is 13 mm or more
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted
- .6 Use variable support spring hangers for first four hanger points on piping connected with flexible connections to vibration isolated equipment.

3.3 HANGER SPACING

- .1 Plumbing piping: to the most stringent requirements of the Authority Having Jurisdiction, Provincial Code, and the National Plumbing Code of Canada.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Within 300 mm of each elbow.
- .6 Space hangers for copper and steel pipe in accordance with the following table:

Pipe Size: NPS	Maximum Spacing (m)	Rod diameter (mm)
up to 1-1/4	2.4	10

Pipe Size: NPS	Maximum Spacing (m)	Rod diameter (mm)
1-1/2	2.4	10
2	3.0	10
2-1/2	3.0	10
3	3.6	10
4	3.6	12
6	4.3	16

- .7 Pipework greater than NPS 12: to MSS SP69.
- .8 Space hangers for plastic piping in accordance with pipe manufacturers installation recommendations.

3.4 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.
- .4 Double-nut all attachments to hanger rods for piping over NPS $\frac{3}{4}$.

3.5 PIPE MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.
- .3 Where horizontal pipe movement is between 13 mm and 25 mm , ensure that hanger length is at least 300mm long, use adjustable clevis hangers, offset pipe hanger and support so that rod hanger is vertical in the hot position.
- .4 Where horizontal pipe movement is greater than 25 mm, use pipe roller supports.
- .5 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted
- .6 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical
 - .2 Variation in supporting effect does not exceed 25% of total load

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions
 - .2 Equalize loads
- .2 Adjustable clevis:

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- .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

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 National Research Council Canada (NRCC)
 - .1 Alberta Fire Code (AFC)
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 24.2-M86 – Identification of Medical Gas Container, Pipelines and Valves
 - .2 CAN/CGSB 24.3 – Standards for Pipe Identification
- .3 Canadian Petroleum Products Institute (CPPI)
 - .1 CPPI Colour-System to Mark Equipment and Vehicles for Product Identification
- .4 Canadian Standards Association (CSA)
 - .1 CSA B149.1, Natural Gas and Propane Installation Code
- .5 Workplace Hazardous Materials Information System (WHMIS)

1.2 EXISTING IDENTIFICATION SYSTEMS

- .1 When modifying a portion of an existing system, provide identification that matches that of the existing otherwise provide identification in accordance with the requirements of this section.

1.3 PIPING IDENTIFICATION SYSTEMS GOVERNED BY CODES AND STANDARDS

- .1 Where identification of systems are governed by Codes or specified to be in accordance with a specific Standard, the requirements of those Codes or Standards shall take precedence over the requirements of this section.
- .2 Applicable Codes and Standards that supersede the requirements of this section include, but are not limited to:
 - .1 Natural Gas: to CSA/CGA B149.1 or authority having jurisdiction

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Systems and Equipment Identification Directory
 - .2 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.5 SYSTEMS AND EQUIPMENT IDENTIFICATION DIRECTORY

- .1 General Requirements

- .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a directory showing the nomenclature used for all mechanical system and service identification.
 - .2 Submittal Format
 - .1 List of all tagged equipment (on both the drawings and specifications) with the following:
 - .1 Short description of equipment function
 - .2 Equipment tag number that will appear on the nameplates
 - .3 Description of the equipment location
 - .2 List of all piping and ductwork system with the following:
 - .1 Short description of system function
 - .2 The following identification information for each system:
 - .1 The label identification nomenclature
 - .2 The symbols that will be used (flow arrow, etc.)
 - .3 Actual dimensions of text and arrows
 - .4 Identification colors/banding etc.
 - .3 Provide a reduced scale, color drawing showing a typical example sample of:
 - .1 An equipment nameplate
 - .2 The actual identification of a distribution system as it will appear as applied on site
 - .3 Sample of above-ceiling equipment markers that will be used

1.6 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.8 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.9 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of all tagged equipment provided in the specifications but not already shown on the plan drawings

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 to be raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: Manufacturer's name, model, size, serial number, capacity
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size

2.2 LAMINATED PLASTIC NAMEPLATES

- .1 Colours:
 - .1 Black letters, white background (except where required otherwise by applicable codes)
- .2 Construction:
 - .1 3 mm thick laminated plastic matte finish, with square corners, letters accurately aligned and machine engraved into core
- .3 Lettering Sizes:
 - .1 Terminal cabinets, control panels: 8 mm high lettering
 - .2 Equipment in Mechanical Rooms or Outdoors: 20 mm high lettering
 - .3 Equipment located elsewhere: 12 mm high lettering

2.3 PIPING AND DUCTING SYSTEMS IDENTIFICATION

- .1 Stencils: With clean cut symbols and letters of following size:
 - .1 20-30 mm Outside Diameter of Insulation or Pipe: 15 mm high letters
 - .2 40-50 mm Outside Diameter of Insulation or Pipe: 20 mm high letters
 - .3 65-150 mm Outside Diameter of Insulation or Pipe: 30 mm high letters
 - .4 Over 150mm Outside Diameter of Insulation or Pipe: 65 mm high letters

- .5 Ductwork and Equipment: 65 mm high letters
- .6 Flow arrowhead height to match letter height
- .2 Stencil Paint: Semi-gloss enamel, black color
- .3 Identify contents by legend and pictogram (where required) and direction of flow by arrows using stencilled painted markings.
- .4 Pictograms:
 - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations
 - .2 Including:
 - .1 Radiation hazard.
 - .2 Biohazard.
- .5 Legend:
 - .1 Block capital letters
- .6 Arrows showing direction of flow:
 - .1 Use double-headed arrows where flow is reversible
- .7 Legends:
 - .1 Where not listed, obtain direction from Departmental Representative
 - .2 Legends for piping systems:

Background Color	Legend Arrows
Yellow	Black
Green	White
Blue	White
Red	White

- .8 Background color marking and legends for piping systems (based on General Paint Custom Colors)

System	Paint Code No.	Color
MISCELLANEOUS		
Electrical Motors, Lines, and Switches	4836-A	Dark Blue
Gas Lines, Hand Rails, & Valve Handles	4798-A	Dark Yellow
Equipment Bases	Floor & Porch Enamel	Medium Gray

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System	Paint Code No.	Color
Control Air Tubing	To Division 25	-
Conduit for Low Voltage Wiring	To Division 25	-

- .9 Legend for ductwork systems:

Duct Service	Legend
Supply Air, Air Handling Unit #[]	S/A – AH – []
Return Air, Air Handling Unit #[]	R/A – AH – []
Outside Air Intake, Air Handling Unit #[]	O/A – AH – []
Exhaust or Relief Air, Air Handling Unit #[]	E/A – AH – []

2.4 VALVE IDENTIFICATION

- .1 Valve Tags: tags with 12 mm high lettering and brass jack chain for fastening to valve. Following types of valve tags are acceptable:
- .1 Brass tags: 40 mm diameter.
 - .2 Plastic tags: 50 mm x 50 mm
 - .3 Anodized aluminum tags: 40 mm diameter

2.5 BUILDING AUTOMATION SYSTEM (BAS) IDENTIFICATION

- .1 BAS Identification Tags: 0.75 mm thick plastic laminated tags imprinted with tag label information with brass jack chain for attachment to device. Include following minimum information on point tag label:
- .1 Logical Point Name
 - .2 Point Multiplexer Address
 - .3 Associated System Identification
 - .4 Point Description
- .2 BAS Laminated Directories: permanently mounted, laminated directories:
- .1 BAS Equipment Panel Directory: show locations of each transducer, actuator or other piece of equipment in panel
 - .2 BAS Wiring Panel Directory: in each panel where control wiring terminates, provide a cross-reference listing between key name, descriptors, hardware address and numbered tape markings on wiring

Part 3 Execution

3.1 GENERAL INSTALLATION

- .1 Submit samples of identification system for Departmental Representative and owner review prior to installation.
- .2 Provide identification only after all painting has been completed.
- .3 Provide ULC or CSA registration plates as required by respective agency.
- .4 Identify all equipment listed on equipment schedules on drawings and specifications with laminated plastic nameplates.

3.2 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 in any way

3.3 PIPING AND DUCTWORK IDENTIFICATION SYSTEMS

- .1 Apply piping and ducting identification systems to all piping and ducting except piping or ducting that is located in non-accessible chases and furred-in spaces. Apply identification to all piping and ducting in ceiling spaces.
- .2 Locate piping and ducting identification as follows:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: At not more than 15m 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 (1.5 sq. m or less) through which piping or 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 pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening
 - .7 At beginning and end points of each run and at each piece of equipment in run
 - .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side
- .3 Identification shall be easily observable from normal operating areas and maintenance access locations.
 - .1 Position of identification to be 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
- .4 Additional requirements for particular piping systems:
 - .1 Natural gas and propane gas:
 - .1 Paint outdoor piping system yellow to CAN/CGAB149.1
 - .2 Apply legend and flow arrows to CAN/CGAB149.1

3.4 VALVES, CONTROLLERS

- .1 Tag all valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.5 BUILDING AUTOMATION SYSTEM (BAS) IDENTIFICATION

- .1 Use BAS mnemonics specified in BAS specification sections on tags and nameplates to identify BAS physical points and equipment.
- .2 Identify the following BAS output controls and input sensor devices with BAS Identification Tags:
 - .1 Field points
 - .2 Sensors
 - .3 Actuators
 - .4 Devices
- .3 Identify the following BAS components with Laminated Plastic Nameplates:
 - .1 Remote control unit (RCU) panels
 - .2 Subpanels
 - .3 Associated equipment panels
 - .4 Panel mounted valves; identify function of each valve

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Movement and Control Association International, Inc. (AMCA)
 - .1 ANSI/AMCA Standard 204-05 (R2012), Balance Quality and Vibration Levels for Fans
- .2 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE Standard 111, Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
- .3 Canadian Associated Air Balance Council (CAABC)
 - .1 National Standard for Total System Balance
- .4 National Environmental Balancing Bureau (NEBB)
 - .1 NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Systems Testing, Adjusting, and Balancing

1.2 ABBREVIATIONS

- .1 AABC – Associated Air Balance Council
- .2 TAB – Testing, adjusting, and balancing
- .3 TAB Agency – An independent entity certified to perform testing and balancing work.
- .4 TABB – Testing, Adjusting, and Balancing Bureau
- .5 NEBB – National Environmental Balancing Bureau

1.3 GENERAL REQUIREMENTS

- .1 Intent
 - .1 The general intent of testing, adjusting, and balancing (TAB) is to:
 - .1 Verify proper and safe operation
 - .2 Determine actual point of performance
 - .3 Evaluate qualitative and quantitative performance of equipment and systems
 - .4 Adjust and regulate equipment and systems to meet specified performance requirements under normal, emergency, and special control mode conditions
 - .5 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges
- .2 Coordination:

- .1 Schedule TAB (including verification and re-verification) into project construction schedule to ensure that TAB has been verified as complete well in advance of Substantial Completion
- .2 Perform TAB of each system independently unless interlocked with other systems
- .3 Operation of Systems for TAB During Construction:
 - .1 Refer to 20 05 01 - Use of Mechanical Systems During Construction
 - .2 Operate systems for length of time required for TAB and as that required for TAB verification
- .4 Special TAB Considerations:
 - .1 Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations
- .5 Commissioning:
 - .1 Perform TAB and provide required reports independently from any commissioning exercises
 - .2 The Tab Agency shall cooperate with the Commissioning Agent and perform the required services in accordance with the requirements of Division 01

1.4 QUALITY ASSURANCE

- .1 Qualifications of the Tab Agency
 - .1 TAB shall be performed by one of the following TAB Agencies:
 - .1 Enviro-Metrics Technical Services Ltd.
 - .2 Hydro-Air Technical Services
 - .3 Perfection Aire Ltd.
- .2 TAB Procedures
 - .1 TAB of systems and equipment that are regulated by codes shall be to the satisfaction of Authority Having Jurisdiction.
 - .2 Perform TAB in accordance with the following Standards supplemented by the procedures defined by this Section:
 - .1 *ANSI/ASHRAE Standard 111, Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems and its associated addenda and errata.*
 - .3 TAB procedures and submittal documentation shall be performed in accordance with the standards defined by the applicable TAB association and *ANSI/ASHRAE Standard 111, Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.*
 - .4 Where TAB of systems or system components are not covered by standard TAB procedures or defined by Section, the TAB Agency shall develop and document an appropriate procedure and include it in the Pre-TAB Report.
- .3 Measurement Accuracy Tolerances
 - .1 Calibration:

- .1 Calibration of instruments shall be in accordance with the TAB association procedures
- .2 Accuracy of Measurement Tool and Measurements:
 - .1 Air and Water Flow Rates: $\pm 2\%$ of actual values
 - .2 Pressure Differentials: Capable of measuring to at least two decimal places
- .4 Performance Accuracy Tolerances
 - .1 Provide TAB as required in order to achieve design performance values within the following tolerances:
 - .1 Fan Airflows: $\pm 5\%$
 - .2 Diffuser/Grille Airflows: $\pm 5\%$
- .5 Where required room/space pressure differentials are required, the pressure differential shall have priority over airflow tolerances.

1.5 REQUIRED TAB DOCUMENTATION AND MEASUREMENTS

- .1 The following defines the required TAB data and measurements for inclusion in the TAB Report.
- .2 Where multiple items of equipment run in parallel during normal operation (air-handling units, pumps, fans, etc.), but have control sequences that require them to run independently during certain modes, provide all required TAB data for both modes of operation.
- .3 General Data Requirements
 - .1 Provide the following TAB data for each item of equipment with an equipment tag:
 - .1 Equipment Tag
 - .2 Equipment Location
 - .3 Equipment Manufacturer
 - .4 Equipment Model Number
 - .5 Equipment Serial Number
 - .6 Date TAB was performed
 - .2 Provide the following TAB data for each item of equipment than has an electrical motor:
 - .1 Frame Size
 - .2 Nameplate horsepower rating
 - .3 Actual brake horsepower
 - .4 Nameplate and measured voltage (each phase)
 - .5 Phase, and frequency
 - .6 Nameplate and measured amperage (each phase)
 - .7 Motor RPM
 - .8 Heater size
 - .9 Service factor

- .10 Starter size and thermal protection rating
- .11 Sheave make/size/bore
- .12 Motors Driven By Variable-Frequency Controllers: Test the manual bypass of the controller to prove proper operation.
- .4 Air System Data Requirements
 - .1 Provide the following TAB data:
 - .1 Airflow Measurement Stations:
 - .1 Duct size
 - .2 Duct area
 - .3 K-factor
 - .4 Pressure drop across measurement station
 - .5 Actual velocity measured at each traverse grid point
 - .6 Design and actual air velocity
 - .7 Design and actual air flows
 - .8 Air dry-bulb temperature (at time of measurement)
 - .9 Air correction factor
 - .10 Actual measurement station location marked on the plan drawings
 - .2 Air Handling Units:
 - .1 Total supply-side internal design pressure
 - .2 Total return-side internal design pressure
 - .3 Actual pressure of each internal compartment of the air handling unit
 - .4 Actual pressure drop across each internal component of the air handling unit (i.e. coils, filters, attenuators, heat wheels, air-mixers, etc.) (indicate the airflow and air temperature at the time of the measurement)
 - .3 Air Inlets and Outlets (including connections to hoods and equipment):
 - .1 Neck/grille size
 - .2 Design and actual air flows (provide a means to cross-reference the airflows for each grille/diffuser indicated in the report with the plan drawings such as by including a simple distribution sketch that matches the plan drawings)
 - .4 Control Dampers Exposed to Outdoor Temperatures:
 - .1 Measure temperature on both sides of damper (to check leakage)
 - .5 Duct Humidifier:
 - .1 Design and actual steam or water flow rate
 - .6 Duct Traverses:
 - .1 Duct size
 - .2 Duct area
 - .3 K-factor
 - .4 Actual velocity measured at each traverse grid point

- .5 Design and actual air velocity
- .6 Design and actual air flows
- .7 Air dry-bulb temperature (at time of measurement)
- .8 Air correction factor
- .7 Fans:
 - .1 Design and actual air flows
 - .2 Design and actual fan RPM
 - .3 Design and actual inlet pressure
 - .4 Design and actual discharge pressure
 - .5 Design and actual total external pressure
 - .6 Pulley size
 - .7 Belt size
 - .8 Fan curve showing operating point and OP efficiency
 - .9 VFD-Controlled Fans: Actual pressure sensor location marked on the plan drawings
 - .10 VFD-Controlled Fans: Design and actual static pressure sensor setpoint used for fan control
- .8 Filters
 - .1 Actual pressure drop across filter

1.6 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Pre-TAB Execution Report

1.7 PRE-TAB EXECUTION REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a report identifying procedures that will be used for the execution of each Closeout Submittal of this Section.
 - .2 Submittal Format
 - .1 TAB Qualifications
 - .1 TAB association membership certifications for the TAB Agency
 - .2 Documentation of successful experience of personnel performing TAB
 - .3 Names of all personnel performing TAB
 - .4 TAB association membership certifications for the personnel performing TAB

- .2 TAB Schedule
 - .1 Anticipated start of TAB
 - .2 Anticipated completion date of TAB
 - .3 Scheduled date of Post-Occupancy TAB
- .3 Strategies and Procedures
 - .1 A listing of equipment and systems that will undergo TAB (as required by the Required TAB Documentation and Measurements)
 - .2 A description of the standard procedures used by the applicable TAB Standard
 - .3 Additional TAB procedures developed by the TAB Agency for systems or system components without previously established TAB Standards
 - .4 Sample TAB forms showing the format the required TAB Data will appear in
- .4 Instrumentation
 - .1 A description of the instrumentation that will be used for TAB

1.8 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Test Reports
 - .1 TAB Report
 - .2 Post-Occupancy TAB Report
 - .2 Operation and Maintenance Manuals Content
 - .3 Contractor As-Built Markups Content

1.9 TAB REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a TAB report containing a complete record of all final parameter set-point for all equipment requiring TAB
 - .2 Submittal Format
 - .1 Title Page:
 - .1 TAB Agency name
 - .2 TAB Agency address
 - .3 TAB Agency contact information
 - .4 Project name
 - .5 Project location

- .6 Project Architect
- .7 Project Engineer
- .8 Project Contractor
- .9 Project altitude
- .10 Report date
- .2 Table of Contents
- .3 Performance Guaranty:
 - .1 Certification Statement
 - .2 Name, signature, and certification numbered of applicable TAB Agency membership
- .4 General TAB Overview:
 - .1 Description of test conditions at the time of TAB
 - .2 Description of the procedures used to perform TAB
 - .3 Notable characteristics of system
 - .4 A list of items or issues that do not meet design tolerances with information that may be considered for resolving the deficiencies
- .5 Instrument List:
 - .1 Instrument type
 - .2 Instrument manufacturer
 - .3 Instrument model number
 - .4 Instrument serial number
 - .5 Instrument range
 - .6 Instrument calibration date
- .6 Required TAB Documentation and Measurements
- .3 Submittal Procedure
 - .1 Do not submit in-progress TAB reports unless requested by the Departmental Representative.
- .4 Verification
 - .1 After TAB is complete and accurately documented in the TAB Report, arrange for verification of the data.
 - .2 The TAB Agency shall conduct the verification in the presence of:
 - .1 The Departmental Representative
 - .2 The Authority Having Jurisdiction (for all life-safety systems)
 - .3 The Commissioning Agent
 - .3 If emergency power has been provided for the operation of any item of equipment, verification shall be conducted on both normal and emergency power.
 - .4 The Departmental Representative shall select specific TAB data for verification of accuracy of reported values.
 - .5 Selected data shall be limited to the extent of measurements that can be verified over 8-hours.

- .6 If the verified measurements differ from those documented in the TAB Report by more than the permitted tolerances, the verification measurement shall be noted as "FAILED."
- .7 If the number of "FAILED" verification measurements is greater than 10 percent of the total measurements checked during verification, the TAB shall be considered incomplete.
- .5 Re-verification
 - .1 If TAB is incomplete due to failed verification of data:
 - .1 The TAB Agency shall:
 - .1 Recheck all measurements and make adjustments as required to complete and correct the TAB
 - .2 Update the TAB Report with the new values, and
 - .3 Resubmit the TAB Report and request a second verification.
 - .2 Bear costs to repeat TAB verification as required until complete.

1.10 COMPLETION OF TAB

- .1 TAB shall be considered complete when:
 - .1 The Pre-TAB Report is complete and has been submitted
 - .2 The TAB Report is complete and has been completed
 - .3 The Post-Occupancy TAB Report is complete and has been submitted
 - .4 All required TAB data has been provided

Part 2 Products

2.1 SECTION NOT USED

Part 3 Execution

3.1 GENERAL TAB PROCEDURES

- .1 Timing of TAB:
 - .1 Perform TAB activities in accordance with the standard construction activity timeline as indicated by the applicable TAB association
 - .2 Provide adequate time within the Construction schedule to perform TAB allowing for multiple TAB exercises as required in order to meet the specified performance parameters
- .2 Coordination of TAB:
 - .1 Coordinate TAB activities with the work of other Divisions
 - .2 Coordinate TAB activities with the Commissioning Agent
- .3 Pre-TAB Requirements:
 - .1 Systems Perform TAB after:

- .1 Mechanical systems are completely installed and equipment start-up has been performed
- .2 Electrical systems are complete including testing of emergency power
- .3 Confirming that the building envelope and pressure-controlled room/areas is sealed and tested
- .4 Controls and programming are complete and tested (including controller workstation graphics)
- .5 Ducted systems have been cleaned with leakage confirmed to be within specified tolerances
- .6 After verifying that balancing devices such as test ports, gauge cocks, flow-control devices balancing valves and fittings, and manual volume dampers are installed, and that their locations are accessible and appropriate for effective balancing
- .2 Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to perform TAB
- .3 Identify any deficiencies that would prevent proper completion of the TAB work prior to performing TAB
- .4 Post-TAB Requirements:
 - .1 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings
 - .2 Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings

3.2 TAB OF AIR SYSTEMS

- .1 Airflow Balancing:
 - .1 Adjust air handling and distribution systems to provide required or design supply, return and exhaust air quantities at site altitude
 - .2 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise
 - .3 Vary total system air quantities by adjustment of fan speeds providing drive changes as required
 - .4 Vary branch air quantities by damper regulation
 - .5 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions
 - .6 Take measurements and balance at extreme conditions when modulating dampers are provided
- .2 Air Velocity Measurements:
 - .1 Make air quantity measurements in ducts by pitot-tube traverse of entire cross sectional area of duct

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END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Z320-11 Building Commissioning
- .2 ASHRAE 202-2013 - Commissioning Process for Building and System

1.2 ABBREVIATIONS

- .1 BOD – Basis of Design
- .2 CA – Commissioning Authority
- .3 OPR – Owner’s Project Requirements

1.3 DEFINED TERMS

- .1 The definitions of this section are not meant to supersede definitions of the Building Code, Standards, or Contract documents and apply only to these Contract Documents.
- .2 *Basis of Design* means documentation of the primary thought processes and assumptions behind design decisions that were made to meet the owner’s project requirements (OPR). The basis of design describes the systems, components, conditions, and methods chosen to meet the OPR.
- .3 *Commissioning* means the coordination of all activities related to the design, construction, start-up, verification, performance testing, and optimization of equipment and systems to ensure that the facility operates in conformity with the design intent.
- .4 *Commissioning Authority* means an individual or company identified by an owner to lead the commissioning team in the implementation of the commissioning process.
- .5 *Commissioning Check Sheets* means the forms used to document the inspections, tests, etc., performed during the commissioning process.
- .6 *Commissioning Plan* means the overall document that outlines the organization, scheduling, resources, activities, documentation, etc., pertaining to the commissioning process.
- .7 *Control Zone* means an area of separate thermostatic control.
- .8 *Design Intent* means the performance that a design is intended to achieve in order to meet the Owner’s Project Requirements and basis of design.
- .9 *Functional Performance Testing* means a full range of tests under actual load, conducted to verify that specific systems, subsystems, components, and interfaces between systems to confirm given criteria. These tests are typically used to verify that a sequence of operation is correctly implemented and that the design intent has been met. They are typically performed after equipment is placed in full operation.
- .10 *Integrated Systems Testing* means work that is performed by the *Integrated Testing Coordinator* after *commissioning* is complete to prove that individual systems operate and perform to the design intent and specification together with other commissioned systems.

- .11 *Owner's Project Requirements* means a dynamic document that provides the explanation of the ideas, concepts, and criteria that are considered to be very important to the owner. The OPR should cite the specific measureable goals for the owner's objective to the greatest extent possible.
- .12 *Performance Testing* means the full range of tests and checks carried out to determine whether components, subsystems, systems, and interfaces between systems function in accordance with the design intent. Performance testing includes modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.
- .13 *Third Party* means an individual/contractor who is independent of the design team and general contractor and authorized by the owner to act as a commissioning authority.

1.4 INTENT

- .1 This Section supplements the commissioning requirements specified in Division 01.
- .2 The intent of this Section is to provide a general overview of the Contractor's responsibilities during the commissioning of the mechanical systems in accordance with the Commissioning Plan.
- .3 The requirements of this Section shall supplement, rather than replace or override any other requirements found in other specification Sections.
 - .1 Equipment start-up, testing, adjusting, balancing, and performance verification, and general quality control checking shall be provided by the installing Contractor independent and separate from Commissioning Activities.
 - .2 All specified Action and Information and Closeout Submittals of other Sections shall be provided separately from any Commissioning activity or Commissioning Submittal.
 - .3 Complete and submit all Action and Information and Closeout Submittals prior to performing Commissioning activities.
 - .4 Commissioning documentation shall be submitted separately from the submittals required by other Sections.

1.5 START-UP SHEETS

- .1 Provide forms for use in presenting start-up and testing data including physical point confirmation.
- .2 Submit sample of each form type to Departmental Representative for review at least 30 days prior to commencement of start-up and testing.

1.6 RESPONSIBILITY OF THE MECHANICAL CONTRACTOR – HVAC

- .1 Provide start-up for all HVAC equipment, except for the building automation control system.
- .2 Assist and cooperate with the TAB contractor and CA by:
 - .1 Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - .2 Including cost of sheaves and belts that may be required by TAB.

- .3 Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
- .4 Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
- .3 List and clearly identify on the as-built drawings the locations of all air-flow stations.
- .4 Prepare a preliminary schedule for Division 20 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.
- .5 Notify the CM or CA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the CM or CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

1.7 RESPONSIBILITIES OF THE TAB CONTRACTOR

- .1 Six weeks prior to starting TAB, submit to the CM the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.
- .2 Submit the outline of the TAB plan and approach for each system and component to the CA, CM and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
- .3 The submitted plan will include:
 - .1 Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
 - .2 An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
 - .3 All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - .4 Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - .5 Final test report forms to be used.
 - .6 Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
 - .7 List of all air flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

- .8 Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations).
- .9 The identification and types of measurement instruments to be used and their most recent calibration date.
- .10 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
- .11 Confirmation that TAB understands the outside air ventilation criteria under all conditions.
- .12 Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
- .13 Details of how building static and exhaust fan / relief damper capacity will be checked.
- .14 Proposed selection points for sound measurements and sound measurement methods.
- .15 Details of methods for making any specified coil or other system plant capacity measurements.
- .16 Details of any TAB work to be done in phases.
- .17 Details regarding specified deferred or seasonal TAB work.
- .18 Details of any specified false loading of systems to complete TAB work.
- .19 Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
- .20 Plan for formal progress reports (scope and frequency).
- .21 Plan for formal deficiency reports (scope, frequency and distribution).
- .4 A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and CM at least twice a week.
- .5 Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
- .6 Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
- .7 Provide the CA with any requested data, gathered, but not shown on the draft reports.
- .8 Provide a final TAB report for the CA with details, as in the draft.
- .9 Conduct functional performance tests and checks on the original TAB as specified for TAB in Section 20 50 02.

1.8 RESPONSIBILITY OF THE CONTROLS CONTRACTOR

- .1 Sequences of Operation Submittals: The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 - .1 An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
 - .2 All interactions and interlocks with other systems.
 - .3 Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 - .4 Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
 - .5 Start-up sequences.
 - .6 Warm-up mode sequences.
 - .7 Normal operating mode sequences.
 - .8 Unoccupied mode sequences.
 - .9 Shutdown sequences.
 - .10 Capacity control sequences and equipment staging.
 - .11 Temperature and pressure control: setbacks, setups, resets, etc.
 - .12 Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - .13 Effects of power or equipment failure with all standby component functions.
 - .14 Sequences for all alarms and emergency shut downs.
 - .15 Seasonal operational differences and recommendations.
 - .16 Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - .17 Schedules, if known.
 - .18 To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.
- .2 Control Drawings Submittal
 - .1 The control drawings shall have a key to all abbreviations.
 - .2 The control drawings shall contain graphic schematic depictions of the systems and each component.
 - .3 The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - .4 Provide a full points list with at least the following included for each point:
 - .1 Controlled system

- .2 Point abbreviation
 - .3 Point description
 - .4 Display unit
 - .5 Control point or setpoint (Yes / No)
 - .6 Monitoring point (Yes / No)
 - .7 Intermediate point (Yes / No)
 - .8 Calculated point (Yes / No)
 - .9 Key:
 - .10 **Point Description:** DB temp, airflow, etc.
 - .11 **Control or Setpoint:** Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
 - .12 **Intermediate Point:** Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
 - .13 **Monitoring Point:** Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
 - .14 **Calculated Point:** "Virtual" point generated from calculations of other point values.
 - .15 The Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.
-
- .3 An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
 - .4 Assist and cooperate with the TAB contractor in the following manner:
 - .1 Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
 - .2 For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.
 - .3 Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
 - .5 Assist and cooperate with the CA in the following manner:
 - .1 Using a skilled technician familiar with the building, execute the functional testing of the controls system as specified for the controls contractor in Section 20 50 02 and Division 26. Assist in the functional testing of all equipment specified in Section 20 50 02 and Division 26. Provide two-way radios during the testing.

- .2 Execute all control system trend logs specified in Section 20 50 02 and Division 26
- .6 The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, according to the process in Division 1. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
 - .1 System name
 - .2 List of devices
 - .3 Step-by-step procedures for testing each controller after installation, including:
 - .1 Process of verifying proper hardware and wiring installation
 - .2 Process of downloading programs to local controllers and verifying that they are addressed correctly
 - .3 Process of performing operational checks of each controlled component
 - .4 Plan and process for calibrating valve and damper actuators and all sensors
 - .5 A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values
 - .4 A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has “passed” and is operating within the contract parameters.
 - .5 A description of the instrumentation required for testing.
 - .6 Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CA and TAB contractor for this determination.
- .7 Provide a signed and dated certification to the CA and CM upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
- .8 Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Section 25 90 02.
- .9 List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

1.9 SYSTEM DEMONSTRATION AND TRAINING REQUIREMENTS

- .1 General Requirements:
 - .1 This section supplements the System Demonstration and Training requirements of:
 - .1 Section 20 00 01 – Common Work Results
 - .2 Section 25 05 01 – EMCS General Requirements
- .2 Supplemental System Demonstration and Training Plan Requirements
 - .1 Submittal Procedure:

- .1 Submit one (1) copy to the Commissioning Authority for review a minimum of twenty (20) working days prior to the first planned training session date.
 - .2 Incorporate the Commissioning Authority's comments into the System Demonstration and Training Plan prior to submitting for the Departmental Representative's review.
 - .2 Format:
 - .1 Make revisions to the System Demonstration and Training Plan as required by the Commissioning Authority.
 - .3 Acceptance Criteria:
 - .1 The System and Demonstration Training Plan shall be considered complete upon written acceptance by the Commissioning Authority.
- .3 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
- .4 The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .5 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.
- .6 Duration of Training: The mechanical contractor shall provide training on each piece of equipment including but not limited to the following:
- .7 System:
 - .1 Air Handler Units
- .8 The Controls Contractor shall have the following training responsibilities:
 - .1 The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 - .2 Provide the CA with a training plan four weeks before the planned training according to the outline described in Division 1.
 - .3 The controls contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.
 - .4 Training manuals: The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the CA. Copies of audiovisuals shall be delivered to the Owner.
 - .5 The trainings will be tailored to the needs and skill-level of the trainees.

- .6 The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
- .7 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .8 The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
- .9 There shall be three training sessions:
 - .1 Training I. Control System: The first training shall consist of 2 days of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system
 - .2 Training II. Building Systems: The second session shall be held on-site for a period of 3 days of actual hands-on training after the completion of system commissioning. The session shall include instruction on:
 - .1 Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems
 - .2 Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc
 - .3 All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer
 - .4 Every screen shall be completely discussed, allowing time for questions
 - .5 Use of keypad or plug-in laptop computer at the zone level
 - .6 Use of remote access to the system via phone lines or networks
 - .7 Setting up and changing an air terminal unit controller
 - .8 Graphics generation
 - .9 Point database entry and modifications
 - .10 Understanding DDC field panel operating programming (when applicable)
 - .3 Training III: The third training will be conducted on-site six months after occupancy and consist of 3 days of training. The session will be

structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

- .9 The TAB contractor shall have the following training responsibilities:
 - .1 TAB shall meet for one day with facility staff after completion of TAB and instruct them on the following:
 - .1 Go over the final TAB report, explaining the layout and meanings of each data type
 - .2 Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water
 - .3 Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity
 - .4 Discuss any temporary settings and steps to finalize them for any areas that are not finished
 - .5 Other salient information that may be useful for facility operations, relative to TAB

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 FUNCTIONAL TEST REPORTS

- .1 Freeze Stat Functional Test Report
- .2 Motor Functional Test Report

3.2 FREEZE STAT FUNCTIONAL TEST REPORT

- .1 Applicable Equipment
 - .1 Air Handling Units
- .2 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
 - .2 Refer to Section 25 90 01 – EMCS Sequences of Operation.
- .3 Specific Requirements
 - .1 Commissioning Objectives
 - .1 Verify Freezestat Trips in “Auto: Mode
 - .2 Verify Freezestat Reset
 - .3 Verify Freezestat Trips in “Hand” Mode
 - .4 Verify Freezestat Trips in “Inverter” Mode

- .5 Verify Freezestat Trips in “By-Pass” Mode
 - .6 Verify Freezestat Doesn’t Trip When Manually Controlled Via the Fire Control Panel
 - .2 Required Participants
 - .1 Commissioning Provider
 - .2 Mechanical Contractor
 - .3 Control Contractor
 - .4 Fire/Life Safety Inspector
 - .5 Electrical Contractor
 - .3 Timing of Test
 - .1 Perform test only after Prefunctional Checklists are complete.
 - .2 When possible, perform commissioning when the ambient temperature is below freezing and the outdoor air is at least 10°F cooler than the return air temperature.
 - .1 When commissioning cannot be performed when the ambient temperature is below freezing, simulate freezing conditions using an ice bath or evaporating liquid spray for chilling a device.
 - .3 When possible, perform freezestat commissioning during testing of the fire/life safety system otherwise a separate commissioning exercise will be required to verify operation during a fire/safety control sequence scenario.
 - .4 Special Precautions
 - .1 If testing the system during subfreezing atmospheric conditions, ensure proper care is taken to prevent freezing of the coils
 - .2 Be sure to have an emergency “exit” strategy in place should the test need to be aborted prior to completion.
 - .3 If a test fails, the source of failure should be identified and conveyed to the proper authority.
 - .4 The system shall be retested once the repairs are complete.
- .4 Testing Procedure
 - .1 Verify Freezestat Trips in ‘Auto’ Mode
 - .1 Place the air handling unit in the “auto” mode before starting the test.
 - .2 If the outdoor air temperature is above freezing, use the lowest possible mixed air temperature
 - .1 If the outdoor air temperature is less than the return air temperature, open the outdoor air damper 100% and close the return air damper.
 - .2 If the outdoor air temperature is greater than the return air temperature, close the outdoor air damper and open the return air damper 100%.
 - .3 If the outdoor air temperature is below freezing, the mixed air temperature should be well above freezing during the test.

- .1 Modulate the return air damper and outdoor air damper as necessary to achieve a mixed air temperature that is well above freezing (for example 40°F to 45°F).
 - .2 Adjust the freezestat setpoint until it reaches the actual mixed air temperature. If the mixed air temperature is greater than the highest possible freezestat setpoint, then use an ice bath or tech spray on the freezestat element to lower its temperature.
 - .4 Regardless of the test method used, check the following:
 - .1 Verify supply and return fans shut down.
 - .2 Verify outdoor air damper closes tightly and return air damper opens 100%.
 - .3 Verify other applicable control sequences are executed in the order specified in the design sequence of operations. For example, hot water and chilled water coils open fully, distribution pumps are enabled, etc.
 - .4 Document the temperature at which the freezestat trips and compare with freezestat setpoint. The two temperatures should be within manufacturer's documented accuracy.
- .2 Verify Freezestat Reset
 - .1 Return the freezestat setpoint to its normal setting.
 - .2 Press the reset button on the freezestat.
 - .3 Check the following:
 - .1 Verify supply and return fans start up automatically
 - .2 Verify outdoor and return air dampers automatically return to normal operating positions.
 - .3 Verify other applicable control sequences are executed in the order specified in the design sequence of operations.
- .3 Verify Freezestat Trips in "Hand" Mode
 - .1 Freezestat operation must be verified under all operating conditions for the air handling unit.
 - .2 Place the air handling unit in the "hand" mode before starting the test.
 - .3 Repeat test procedures outlined above to verify proper system operation.
- .4 Verify Freezestat Trips in "Inverter" Mode
 - .1 Repeat test procedures outlined above to verify proper system operation.
- .5 Verify Freezestat Trips in "By-Pass" Mode
 - .1 Repeat test procedures outlined above to verify proper system operation.
- .6 Verify Freezestat Doesn't Trip When Manually Controlled Via the Fire Control Panel
 - .1 Following the procedures outlined above, generate a freezestat trip on an air handling unit and verify proper control over all fans and dampers is executed.
 - .2 Then carry out the various smoke control strategies manually at the fire control panel.
 - .3 Check the following:

- .1 Verify the HVAC system responds to the commands provided by the fire control panel regardless of the freeze stat status.
- .7 Return System to Normal
 - .1 Once all tests are complete, return all control parameters back to original setpoints and conditions per the design sequence of operations.
- .5 Acceptance Criteria
 - .1 Provide documented evidence that all of the commissioning objectives are met.

3.3 MOTOR FUNCTIONAL TEST REPORT

- .1 General Requirements
 - .1 Motors: 1/2 HP and Larger
 - .1 Commission at final balanced conditions and record the following data:
 - .1 Manufacturer's name, model number, and serial number.
 - .2 Motor horsepower rating.
 - .3 Motor rpm.
 - .4 Phase/Hertz (Hz)
 - .5 Nameplate and measured voltage, each phase.
 - .6 Nameplate and measured amperage, each phase.
 - .7 Starter size and thermal-protection-element rating.
 - .8 Service factor and frame size.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
 - .4 ASTM C423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - .5 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement
 - .6 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation
 - .7 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - .8 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation
 - .9 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
 - .10 ASTM C916-85e1, Standard Specification for Adhesives for Duct Thermal Insulation
 - .11 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
 - .12 ASTM C1071-00, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
 - .13 ASTM C1338-00, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
 - .14 ASTM G21-96(2002), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.2, Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers
 - .2 CAN/CGSB-51.9, Mineral Fibre Thermal Insulation for Piping and Round Ducting
 - .3 CAN/CGSB-51.10, Mineral Fibre Board Thermal Insulation
 - .4 CAN/CGSB-51.11, Mineral Fibre Thermal Insulation Blanket

- .5 CAN/CGSB-51.12, Cement, Thermal Insulating and Finishing
- .6 CAN/CGSB-51.40, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering
- .7 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
- .8 CGSB 51-GP-53M, Jacketing, Polyvinyl, Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (DOJ).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .5 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA AH116-5th Edition, Fibrous Glass Duct Construction Standards.
- .6 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Installation of Air Conditioning and Ventilating Systems
 - .2 NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems
- .7 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible
 - .2 SMACNA IAQ Guideline for Occupied Buildings 95.
- .8 Thermal Insulation Association of Canada (TIAC)
 - .1 National Insulation Standards (2005)
- .9 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .2 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering
- .10 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS)

1.2 DEFINED TERMS

- .1 *Concealed* means mechanical services and equipment in:
 - .1 Suspended ceilings
 - .2 Non-accessible service shafts (no door into the shaft)
 - .3 Furred-in spaces.
- .2 *Exposed* means "not concealed" as previously defined and includes:
 - .1 Interstitial spaces
 - .2 All mechanical and service rooms
 - .3 Accessible service shafts (has a door into shaft)
 - .4 Service shafts directly open to mechanical rooms (no partition or fire separation between the spaces)

- .5 *Insulation Systems* means insulation material, fasteners, jackets, and other accessories.
- .6 *K-Value* means thermal conductivity of insulating material ($\text{Wm/m}^2\text{°C}$).
- .7 *R-Value* means thermal resistance of insulating material ($\text{m}^2\text{°C/W}$)

1.3 QUALITY ASSURANCE

- .1 Insulation Contractor Requirements
 - .1 Specialist in performing work of this section.
 - .2 Have at least 3 years of successful experience in this size and type of project.
 - .3 Qualified to standards of TIAC.

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Mock-ups
 - .1 Insulation and Cladding for Roof-Mounted Ductwork Mock-Up-
 - .2 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section.

1.5 INSULATION AND CLADDING FOR OUTDOOR DUCTWORK MOCK-UP

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a mock-up demonstrating the workmanship for the insulation and cladding for roof-mounted ductwork.

1.6 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 10 – Common Work Results – Mechanical indicate the following:
 - .1 Surface coating
 - .2 Water repellency
 - .3 Fungi resistance
 - .4 Bacteria resistance
 - .5 Thickness
 - .6 Surface burning characteristics
 - .7 Sound absorption coefficients

- .8 Materials
- .9 "k" value
- .10 Installed "R" value
- .11 Density
- .12 Finish
- .13 Jacketing
- .14 Installation and maintenance details of removable insulation systems
- .15 Product data test reports (when requested to substantiate rating and performance requirements for the assembly and thickness used)

1.7 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.8 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section into the Operation and Maintenance Manuals in accordance with Section 20 00 10 – Common Work Results - Mechanical.

1.9 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of:
 - .1 Fire wrap
 - .2 Acoustic duct lining

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 Glass Fiber Insulation
 - .1 Johns Manville
 - .2 Fiberglas
 - .3 Manson
 - .4 Knauf

- .5 Owens Corning

2.2 GENERAL REQUIREMENTS

- .1 Fire and Smoke Rating
 - .1 To CAN/ULC-S102
 - .2 Maximum flame spread rating: 25.
 - .3 Maximum smoke developed rating: 50.
- .2 Mineral fibre as specified includes glass fibre, rock wool, slag wool.
- .3 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

2.3 EXTERNAL DUCT INSULATION

- .1 ED-1: Flexible Mineral Fibre Blanket Insulation:
 - .1 Material
 - .1 Flexible mineral fibre blanket insulation to CAN/CGSB-51.11.
 - .2 Thermal Conductivity
 - .1 Maximum k-Value of 0.038 W/m.°C at 24°C mean temperature.
 - .3 Thermal Resistance
 - .1 Minimum installed R-Value of 0.58 m²C/W.
 - .4 Rated Service Temperature
 - .1 -20°C to 65°C.
 - .5 Vapour Barrier
 - .1 Factory applied reinforced aluminum foil vapour barrier to CGSB 51-GP-52Ma.

2.4 DUCT LINER

- .1 DL-1: Flexible Fiberglass Duct Liner with Reinforced Coating:
 - .1 Material
 - .1 Flexible, fibreglass with reinforced antimicrobial coating
 - .2 Airstream Surface Coating
 - .1 Smooth, reinforced, antimicrobial, acrylic polymer
 - .2 Surface coating to be cleanable
 - .3 Fungal and Bacterial Resistance
 - .1 Tested in accordance with ASTM C1338 and ASTM G21.
 - .4 Air Velocity Rating
 - .1 To 30.5 m/s to ASTM C1071.
 - .5 Water Resistance
 - .1 ≥ 6 to INDA IST 80.6.
 - .6 Flame and Smoke Index

- .1 Maximum 25/50 in accordance with CAN/ULC-102.2-M88, NFPA 90A and NFPA 90B, and ASTM E84.
- .7 Thermal Resistance (R)
 - .1 Minimum 1.41 m² degree C/W (based on 51mm thickness and tested in accordance with ASTM C518 at 24 degree C mean temperature).
- .8 Sound-Absorption Coefficients
 - .1 Based on Type A Mounting and 50mm thickness:
 - .1 0.25 at 125 Hz, 0.66 at 250 Hz, 1.00 at 500 Hz, 1.05 at 1000 Hz, 1.02 at 2000 Hz, 1.01 at 4000 Hz and NRC of 0.95 (tested in accordance with ASTM C423 and ASTM E795).
- .9 Length
 - .1 As indicated on the terminal box schedules shown on the drawings.
- .10 Acceptable Material
 - .1 Johns Manville Linacoustic RC
- .2 DL-2: Flexible Fiberglass Duct Liner with Reinforced Coating with Perforated Metal Liner:
 - .1 Material
 - .1 Flexible, fibreglass with reinforced antimicrobial coating
 - .2 Airstream Surface Coating
 - .1 Smooth, reinforced, antimicrobial, acrylic polymer
 - .2 Surface coating to be cleanable
 - .3 Internal Liner
 - .1 Standard acoustic perforated galvanized metal liner with 2.4mm diameter holes staggered at 4.8mm on center for a clear open area of 23% to ASTM A-653.
 - .4 Fungal and Bacterial Resistance
 - .1 Tested in accordance with ASTM C1338 and ASTM G21.
 - .5 Air Velocity Rating
 - .1 To 30.5 m/s to ASTM C1071.
 - .6 Water Resistance
 - .1 ≥ 6 to INDA IST 80.6.
 - .7 Flame and Smoke Index
 - .1 Maximum 25/50 in accordance with CAN/ULC-102.2-M88, NFPA 90A and NFPA 90B, and ASTM E84.
 - .8 Thermal Resistance (R)
 - .1 Minimum 1.41 m² degree C/W (based on 50mm thickness and tested in accordance with ASTM C518 at 24 degree C mean temperature).
 - .9 Sound-Absorption Coefficients
 - .1 Based on Type A Mounting and 50mm thickness:
 - .1 0.25 at 125 Hz, 0.66 at 250 Hz, 1.00 at 500 Hz, 1.05 at 1000 Hz, 1.02 at 2000 Hz, 1.01 at 4000 Hz and NRC of 0.95 (tested in accordance with ASTM C423 and ASTM E795).

- .10 Length
 - .1 As indicated on the terminal box schedules shown on the drawings.
- .11 Acceptable Material
 - .1 Johns Manville Linacoustic RC
- .3 DL-3: Coated Rigid Fiberglass Plenum Liner Board
 - .1 Material
 - .1 Rigid, fibreglass with reinforced antimicrobial coating
 - .2 Airstream Surface Coating
 - .1 Smooth, reinforced, antimicrobial, acrylic polymer
 - .2 Surface coating to be cleanable
 - .3 Fungal and Bacterial Resistance
 - .1 Tested in accordance with ASTM C1338 and ASTM G21.
 - .4 Air Velocity Rating
 - .1 To 30.5 m/s to ASTM C1071.
 - .5 Water Resistance
 - .1 ≥ 6 to INDA IST 80.6.
 - .6 Flame and Smoke Index
 - .1 Maximum 25/50 in accordance with CAN/ULC-102.2-M88, NFPA 90A and NFPA 90B, and ASTM E84.
 - .7 Thermal Resistance (R)
 - .1 Minimum 1.53 m² degree C/W (based on 50mm thickness and tested in accordance with ASTM C518 at 24 degree C mean temperature).
 - .8 Sound-Absorption Coefficients
 - .1 Based on Type A Mounting and 50mm thickness:
 - .1 0.26 at 125 Hz, 0.73 at 250 Hz, 1.10 at 500 Hz, 1.10 at 1000 Hz, 1.04 at 2000 Hz, 1.03 at 4000 Hz and NRC of 1.00 (tested in accordance with ASTM C423 and ASTM E795).
 - .9 Acceptable Material
 - .1 Johns Manville Linacoustic R-300

2.5 RECOVERY MATERIALS

- .1 RM-1: Canvas:
 - .1 Material
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.
 - .2 Lagging Adhesive
 - .1 Compatible with insulation.
- .2 RM-2: Aluminum:
 - .1 Material
 - .1 To ASTM B209.

- .2 Finish
 - .1 Smooth.
- .3 Joining
 - .1 Longitudinal and circumferential slip joints with 50 mm laps.
- .4 Fittings
 - .1 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .5 Metal Jacket Banding and Mechanical Seals
 - .1 19 mm wide, 0.5 mm thick stainless steel at 300mm spacing.
- .6 Outdoor Use
 - .1 Locate all joints and seams the on the sides or bottom and seal all joints and seams with weatherproof caulking.
- .3 RM-3: Stainless Steel:
 - .1 Material
 - .1 Type: 304
 - .2 Thickness
 - .1 0.25 mm sheet
 - .3 Finish
 - .1 Smooth
 - .4 Metal Jacket Banding and Mechanical Seals
 - .1 19 mm wide, 0.5 mm thick stainless steel.
 - .5 Outdoor Use
 - .1 Locate all joints and seams the on the sides or bottom and seal all joints and seams with weatherproof caulking.

2.6 ACCESSORIES

- .1 Vapour Retarder Lap Adhesive
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Cement
 - .1 Finishing Cement
 - .1 To CAN/CGSB-51.12, Type 1 - mineral fibre hydraulic setting thermal insulating and finishing cement for use up to 650°C.
 - .2 Insulating Cement
 - .1 To CAN/CGSB-51.12, Type 2 - mineral fibre thermal insulating cement for use up to 870°C.
- .4 Outdoor Vapour Retarder Mastic
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m2.

- .5 Joint Tape
 - .1 Jacket Tape
 - .1 Self-adhesive, aluminum, reinforced, 75 mm wide minimum.
 - .2 Vapour Barrier Tape
 - .1 Reinforced vapour barrier tape consisting of laminated aluminum foil, glass fibre scrim and paper, with pressure sensitive self adhesive.
- .6 Adhesives
 - .1 To manufacturer's recommendations for insulation or jacket type and application.
- .7 Tie Wire
 - .1 1.5 mm diameter stainless steel.
- .8 Banding
 - .1 19 mm wide, 0.5 mm thick stainless steel.
- .9 Facing
 - .1 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face of insulation.
- .10 Fasteners
 - .1 2 mm diameter pins with nylon or metal retaining clips, length to suit thickness of insulation.
 - .2 Metal retaining clips, 32 mm square.
- .11 Sealer
 - .1 To meet the requirements of NFPA 90A and NFPA 90B.
 - .2 Flame spread rating equal to or less than 25.
 - .3 Smoke development rating equal to or less than 50.
 - .4 Temperature rated for -68 degrees C to 93 degrees C.

Part 3 Execution

3.1 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials to the site in original factory packaging, labelled with the manufacturer's name and address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperature's and conditions as required by the manufacturer.
- .5 Refer to Duct Cleanliness requirements indicated in Section 23 31 13 – Ductwork.

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Air Duct Leakage Test Report indicated in Section 23 31 13 – Ductwork is accepted by the Departmental Representative as complete.

- .2 Duct cleanliness is in accordance with Section 23 31 13 – Ductwork.

3.3 GENERAL INSTALLATION REQUIREMENTS

- .1 General Procedure
 - .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
 - .2 Install in accordance with TIAC National Standards.
- .2 Duct Dimensions
 - .1 Dimensions shown on drawings indicate the inside free dimensions regardless of insulation placement.
 - .2 Fabricate ducts at the required size to accommodate the insulation/duct liner thickness.
- .3 Install insulation over entire surface of duct for full length of duct run except as follows.
 - .1 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and Supports
 - .1 Provide hangers and supports in accordance with Section 20 15 29 - Bases, Hangers, and Supports.
- .6 Insulation Protection
 - .1 Protect insulation where it may be compressed by the weight of ductwork.
- .7 Fasteners
 - .1 Install at 300 mm on centre in horizontal and vertical directions, minimum two rows each side.
- .8 Seams
 - .1 Locate seams in least visible location (except where noted otherwise).
- .9 Installation Temperature
 - .1 Install insulation at ambient temperatures within acceptable ratings for tapes, sealants and adhesives.

3.4 EXTERNAL DUCT INSULATION INSTALLATION

- .1 Securement
 - .1 Adhere mineral fibre insulation to round and oval ductwork with adhesive applied in 150 mm wide strips on 400 mm centres.
 - .2 Band on outside until mastic sets then remove bands.
 - .3 Secure insulation on rectangular ducts with 50% area coverage of adhesive and impale on pins located 400 mm on centre and secure in place with the retaining clips.

.2 Joints

- .1 Butt insulation joints and seal with lap seal adhesive
- .2 Cover joints with 100 mm strips of open mesh cloth imbedded between two coats of lap seal adhesive.
- .3 Cover with vapor barrier tape.

.3 Omit insulation at the following locations:

- .1 At penetrations through walls, insulate up to each face of wall and omit insulation within wall assembly.
- .2 At penetrations through interstitial space floors, omit insulation from 300mm above floor to underside of floor assembly and tape insulation ends to duct above floor.
 - .1 Penetrations to be sealed airtight.
- .3 At balancing dampers on round ducts, omit insulation 75mm upstream and 75mm downstream of damper handle and tape insulation ends to duct.
- .4 At balancing dampers on rectangular ducts, omit insulation for a 200x200mm square area at the insulation handle quadrant and tape insulation ends to duct.

3.5 BREECHING INSULATION INSTALLATION

- .1 Face breeching with 9.5 mm rib lath turn out to provide 12 mm space between insulation and hot surface and 12.5 mm mesh expanded lath on the outside.
- .2 Butt insulation firmly together and secure with 1.6 mm galvanized wire.

3.6 DUCT LINER INSTALLATION

- .1 Where duct liner is required, provide both internal duct liner and external duct insulation as specified.
- .2 General Installation Requirements:
 - .1 Install in accordance with:
 - .1 The recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible (except as specified otherwise).
 - .2 The with manufacturer's recommendations.
 - .2 Do not field-cut into acoustically lined duct.
 - .1 Connect branch take-offs downstream of acoustic duct liner.
- .3 Adhesive
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive to ASTM C916.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres.
 - .3 Protect leading and trailing edges of duct sections with insulation sealer (not adhesive).
- .4 Butt Joints and Exposed Edges

- .1 Seal butt joints exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer.
- .2 Install joint tape in accordance with the manufacturer's written recommendations and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .5 Install galvanized sheet metal nosing on all leading and trailing edges of duct and fastened to duct.
 - .1 Provide tight, overlapped corner joints.
 - .2 Recover entire insulated surface with galvanized perforated metal liner.

3.7 EXTERIOR DUCT INSULATION, BREECHING, AND DUCT LINER SCHEDULE

- .1 Exterior Duct Insulation Schedule:

System	Type	Thickness (mm) ⁽³⁾	Recovery Material
Exterior Duct Insulation for Exhaust and Relief Ductwork Within 3m of Exterior Openings	ED-1	25 ⁽²⁾	RM-1 ⁽¹⁾
Exterior Duct Insulation for Relief Ducts and Plenums	ED-1	25 ⁽²⁾	RM-1 ⁽¹⁾
Exterior Duct Insulation for Outdoor Air Intakes	ED-1	50 ⁽²⁾	RM-1 ⁽¹⁾
Exterior Duct Insulation for Supply Ductwork	ED-1	25 ⁽²⁾	RM-1 ⁽¹⁾
Exterior Duct Insulation for Ductwork Exposed to the Outdoors	ED-1	100 ⁽²⁾	RM-3

Notes:

- .1 Provide specified recovery material in all 'exposed' areas
- .2 Use thickness indicated in schedule unless specially noted otherwise on drawings
- .3 Use thickness indicated in schedule unless specially noted otherwise
- .2 Breeching Insulation Schedule:

System	Type	Thickness (mm) ⁽¹⁾	Recovery Material
Breeching Insulation for Fuel-Fired Appliances with Draft Hood: Vents and Vent Connectors	BR-1	25	RM-2
Breeching Insulation for Fuel-Fired Appliances without Draft Hood: Vents and Vent Connectors	BR-1	50	RM-2

Notes:

- .1 Use thickness indicated in schedule unless specially noted otherwise on drawings

.3 Duct Liner Schedule:

System	Type	Thickness (mm) (²)	Recovery Material
Acoustic Duct Liner within Non-Healthcare Facilities	DL-1	25	-
Acoustic Plenum Liner within Non-Healthcare Facilities	DL-3	50	-

Notes:

- .1 Provide specified recovery material in all 'exposed' areas
- .2 Use thickness indicated in schedule unless specially noted otherwise on drawings

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5, Pipe Flanges and Flanged Fittings
 - .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings
 - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
 - .3 ASTM B32, Specification for Solder Metal
 - .4 ASTM B75M, Standard Specification for Seamless Copper Tube [Metric]
 - .5 ASTM B837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems
- .3 Canadian Standards Association (CSA)
 - .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1, Natural Gas and Propane Installation Code Handbook
 - .2 CAN/CSA B149.2, Propane Storage and Handling Code
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)

1.2 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 32 16.07- Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review [manufacturer's] installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06- Health and Safety Requirements.

- .3 Construction requirements: in accordance with Section 01 47 15- Sustainable Requirements: Construction.
- .4 Verification: contractor's verification in accordance with Section 01 47 17- Sustainable Requirements: Contractor's Verification.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section including:

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00- Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15- Sustainable Requirements: Construction.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Indicate on manufacturers catalogue literature following: valves.
 - .3 Submit WHMIS MSDS in accordance with Section 01 47 15- Sustainable Requirements: Construction and Section 02 81 01- Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Operations and Maintenance Manuals
 - .1 Include the following documentation in the Operations and Maintenance Manuals as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section).
 - .1 Permits
 - .1 Gas permit
 - .2 Commissioning Reports
 - .1 As required by Section 20 30 03 – Mechanical Commissioning
 - .3 Shop Drawings
 - .1 Provide Contractor and Departmental Representative-reviewed Shop Drawings for each product of this section.
 - .4 Maintenance Data
 - .1 Provide Manufacturer's start-up, installation, and troubleshooting instructions for each product of this section
 - .2 Provide a list of spare parts recommended by the Manufacturer for each product of this section.
- .3 As-Built Drawings

- .1 Indicate the following specific information on the Contractor's marked-up As-Built Drawings as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section). This list is not intended to define all of the information required to be shown on As-Built drawings but rather to remind the Contractor to show commonly-missed items.
 - .1 Location of:
 - .1 Relief vents
 - .2 Routing of:
 - .1 Vent piping

Part 2 Products

2.1 ABOVE GROUND PIPING

- .1 Pipe:
 - .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS ½ to 2, screwed.
 - .2 NPS 2 ½ and over, plain end.
 - .2 Copper tube: to ASTM B75M.
- .2 Jointing Material
 - .1 Screwed fittings: pulverized lead paste.
 - .2 Welded fittings: to CSA W47.1.
 - .3 Flange gaskets: nonmetallic flat.
 - .4 Soldered: to ASTM B32.
- .3 Fittings
 - .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
 - .2 Copper pipe fittings, screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.
- .4 Valves
 - .1 Provincial Code approved, lubricated plug or ball type to Section 15110.

2.2 PRESSURE REGULATORS

- .1 Certified to the requirements of CAN/CGA B149.1.
- .2 Capacity to suit load and pressures indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install in accordance with Section 20 20 05 - Installation of Pipework, CAN/CSA B149.1, and applicable Provincial/Territorial Codes, supplemented as specified.
- .2 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.
- .3 Install buried piping inside pipe sleeve where indicated.

3.3 PRESSURE REGULATORS

- .1 Install to the requirements of CAN/CGA B149.1.

3.4 VALVES

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

3.5 PURGING

- .1 Purge after pressure test in accordance with CAN/CGA B149.1.

3.6 PRE-START-UP INSPECTIONS

- .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
- .2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.7 CLEANING AND START-UP

- .1 In accordance with requirements of CAN/CGA B149.1.

3.8 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.
- .2 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its product[s], and

- submit written reports, in acceptable format, to verify compliance of work with Contract.
- .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 at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .4 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.
- .5 Performance Verification:
 - .1 Refer to Section 23 08 01- Performance Verification of Mechanical Piping Systems.
- .6 PV procedures:
 - .1 Test performance of components.

3.9 ADJUSTING

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

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
 - .2 ASTM A635/A635M, Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled
 - .3 ASTM A653/A653M, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)
- .3 National Research Council of Canada (NRCC)
 - .1 National Energy Code of Canada for Buildings
- .4 National Fire Protection Agency (NFPA)
 - .1 NFPA 90A, Installation of Air Conditioning and Ventilating Systems
 - .2 NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems
 - .3 NFPA 91, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Non-combustible Particle Solids
 - .4 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA, Duct Cleanliness for New Construction Guidelines
 - .2 ANSI/SMACNA, HVAC Duct Construction Standards, Metal and Flexible – Latest Edition including addenda
 - .3 SMACNA, HVAC Duct Leakage Test Manual and Technical Research Updates

1.2 DEFINED TERMS

- .1 The definitions of this section are not meant to supersede definitions defined in recognized Codes or Standards and apply only to these Contract Documents.
- .2 *Low Pressure Ductwork* means ductwork subjected to velocities of 2500 fpm or less and operating pressure of 500 Pa or less, positive or negative.
- .3 *Medium and High Pressure Ductwork* means ductwork subjected to an operating pressure in excess of 500 Pa, positive or negative.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Mock-ups
 - .1 Ducted Return Connection to Grille Mock-up

.2 Shop Drawings

.1 Shop drawings for all equipment indicated in this Section including:

- .1 Sealants
- .2 Tape
- .3 Proprietary joints

1.4 DUCTED RETURN CONNECTION TO GRILLE MOCK-UP

.1 General Requirements

- .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.

.2 Specific Requirements

- .1 Scope of Work
 - .1 Provide a mock-up indicating the construction method that will be used for connecting return ductwork to grilles in ceilings and walls.

1.5 SHOP DRAWINGS

.1 General Requirements

- .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.

.2 Specific Requirements

- .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 10 – Common Work Results – Mechanical indicate the following:
 - .1 Pressure and temperature rating
 - .2 Flame spread and smoke development ratings
 - .3 MSDS literature
 - .4 Construction drawings/details for fabricated plenums

1.6 CLOSEOUT SUBMITTALS

.1 Provide the following Closeout Submittals:

- .1 Test Reports
 - .1 Air Duct Leakage Test Report
- .2 Operation and Maintenance Manuals Content
- .3 Contractor As-Built Markups Content

1.7 AIR DUCT LEAKAGE TEST REPORT

.1 General Requirements

- .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.

.2 Specific Requirements

- .1 Scope of Work

- .1 Provide leakage testing for the following systems:
 - .1 Supply Air
 - .2 Return Air
- .2 Leakage testing shall include supply, return, and exhaust ductwork associated with each system.
- .3 Leakage testing is required for high pressure ductwork only.
- .2 Testing Agency
 - .1 Pressure testing and report by installing contractor
- .3 Testing Apparatus
 - .1 Arrange for or provide all temporary services all test apparatus, all temporary seals, and all qualified personnel necessary to conduct specified testing.
 - .2 Test apparatus shall be accurate within plus or minus 7.5% of the indicated flow rate and test pressure and shall have calibration data or a certificate signifying conformance with ASME Requirements for Fluid Meters.
 - .3 Test apparatus shall be as outlined in SMACNA VAC Air Duct Leakage Test Manual and as recommended for good practice.
- .4 Conditions of Test
 - .1 Timing of Test
 - .1 Tests and necessary repairs shall be completed prior to concealment of ducts and before installation of ductwork.
 - .2 Test after seals have cured.
 - .3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.
 - .2 Leak Rate Calculations
 - .1 Leak rate calculations shall be based on the parameters defined by this Section.
 - .1 In absence of defined parameters, use recommended values indicated in SMACNA VAC Air Duct Leakage Test Manual.
 - .2 Test Pressure
 - .1 Static pressure values used for each leak rate calculations shall be equivalent to the duct construction pressure class unless otherwise specified.
 - .1 [System #1 (supply ductwork) 10"]
 - .2 [System #1 (return ductwork) 5"]
 - .3 Leakage Classes
 - .1 Leakage classes used for each leak rate calculations shall be as follows:

Seal Class	C	A
Rectangular Metal	16	4
Round Metal	8	2
- .5 Testing Procedure

- .1 Leakage test procedures shall follow those indicated in SMACNA VAC Air Duct Leakage Test Manual.
 - .2 Positive pressure testing is acceptable for negative pressure systems.
 - .3 Submittal Format
 - .1 Technical Information
 - .1 Provide for each system tested:
 - .1 Summary of specified parameters for leak rate calculations including fan airflow, test pressure, and leakage class
 - .2 Schematic drawing (one each for supply, return, and exhaust as applicable) indicating the extents of each tested segments and segment identification tag corresponding with data provided in tables
 - .3 Calculation of duct surface area (excluding equipment connected in-line)
 - .4 Indicate specified leakage factor for each segment
 - .5 Calculation of the allowable leakage for each test segment and equivalent airflow based on specified parameters
 - .6 Indicate measured leakage rate and equivalent airflow for each segment
 - .7 Indicate if system is compliant with leakage tolerances
 - .8 Indicate date of test, witnesses to test, and flow meter characteristics
 - .4 Acceptance Criteria
 - .1 Measured leak rates for each system shall be less than the permissible leak rate based on the specified leakage class.
 - .1 Where several separate segments within the same system and pressure class are tested for compliance, the aggregate leakage shall not exceed the allowable rate.
 - .2 If tested system fails to meet specified air leakage criteria, the contractor shall modify fabrication methods to bring it into compliance and shall retest it until acceptable duct air leakage is demonstrated.

1.8 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 10 – Common Work Results - Mechanical.

1.9 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements

- .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 All ductwork and fittings showing changes of elevation, radius of all elbows, and sizes of each duct segment
 - .2 All duct accessories including terminal units, manual and automatic dampers, airflow stations, and other accessories
 - .3 Elevations of sections detailing critical height locations
 - .4 Custom fabricated fittings
 - .5 Extent of acoustically lined ductwork indicating length and elbows
 - .6 Locations of access panels in ductwork

Part 2 Products

2.1 RIGID DUCTWORK

- .1 Rectangular
 - .1 Construct to SMACNA standards
 - .2 Transverse joints: to SMACNA for seal class listed
- .2 Round or Oval
 - .1 Construct to SMACNA standards (except snap-lock seams not permitted)
- .3 Fittings
 - .1 General
 - .1 To SMACNA standards
 - .2 Radiused Elbows
 - .1 Rectangular
 - .1 Standard radius
 - .2 Centreline radius of 1.0 times width of duct
 - .2 Round
 - .1 Smooth radius or five-piece
 - .2 Centreline radius of 1.0 times diameter
 - .3 Mitred Elbows (Rectangular)
 - .1 Up to 400 mm
 - .1 Complete with single-thickness turning vanes
 - .4 Branches
 - .1 Rectangular Main to Rectangular Branch
 - .1 Radius on branch 1.0 times width of duct
 - .2 45-degree entry on branch
 - .2 Round Main to Round Branch
 - .1 45-degree entry on branch with conical connection

- .3 Provide and locate volume control damper in branch duct near connection to main duct
- .5 Transitions
 - .1 Diverging
 - .1 20-degree maximum included angle
 - .2 Converging
 - .1 30-degree maximum included angle
- .6 Offsets
 - .1 Full radius elbows
- .7 Obstruction Deflectors
 - .1 Maintain full cross-sectional area
 - .2 Maximum included angles as per transitions.
- .4 Materials
 - .1 Galvanized Steel
 - .1 Lock Forming Quality: to ASTM A653, Z90 zinc coating
 - .2 Thickness, Fabrication and Reinforcement: to SMACNA
 - .3 Joints: to SMACNA
 - .2 Stainless Steel
 - .1 To ASTM A480/A480M, Type 304
 - .2 Thickness, Fabrication and Reinforcement: to SMACNA
 - .3 Joints: to SMACNA unless otherwise indicated
 - .3 Aluminum
 - .1 To SMACNA, Aluminum type: 3003-H-14
 - .2 Thickness, Fabrication and Reinforcement: to SMACNA
 - .3 Joints: to SMACNA
 - .4 Black Steel
 - .1 To ASTM A635/A635M
 - .2 Thickness: 1.2 mm or as indicated
 - .3 Fabrication: ducts and fittings to SMACNA
 - .4 Reinforcement: as indicated
 - .5 Joints: continuous weld

2.2 HANGERS AND SUPPORTS

- .1 Hanger Configuration
 - .1 To SMACNA
- .2 Strap Hangers
 - .1 Same material as duct but next sheet metal thickness heavier
 - .2 Maximum size duct supported by strap hanger: 350 mm
- .3 Hangers

- .1 Prime painted or galvanized steel angle with cadmium plated or galvanized steel rods to SMACNA

2.3 DUCT SEALING

- .1 Seal Classification Schedule:

Maximum Operating Pressure (Pa)	SMACNA Seal Class
All up to 500	C
All above 500	A

- .2 Seal Classification

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
- .3 Class C: transverse joints and connections made air tight with gaskets sealant tape or combination thereof. Longitudinal seams unsealed.

- .3 Sealant

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant
 - .1 Sealant compound rated for high velocity for high pressure ductwork systems
- .2 Temperature range of minus 30 deg C to plus 93 deg C

- .4 Tape

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide

2.4 FIRE-STOPPING

- .1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation
- .2 Fire-stopping material and installation must not distort duct

2.5 DUCT ACCESS

- .1 Refer to Section 23 33 00 – Air Duct Accessories for duct access panel requirements.

Part 3 Execution

3.1 DUCT CLEANLINESS

- .1 Duct cleanliness shall be in accordance with the specified level of duct cleanliness as defined in SMACNA, Duct Cleanliness for New Construction Guidelines.
 - .1 Required level of cleanliness: Basic Level
 - .2 Basic Level
 - .1 Delivery to Site

- .1 Unless otherwise specified, ductwork delivered from the premises of the manufacturer will have no protection. However, care must be taken to prevent damage during transportation and off- loading.
- .2 Installation
 - .1 Before the installation of individual duct sections, they are to be inspected to ensure that they are free from all debris, but not wiped or specially cleaned.
- .3 Installation
 - .1 Before the installation of individual duct sections, they are to be inspected to ensure that they are free from all debris, but not wiped or specially cleaned.
- .4 Protection of Ductwork Risers
 - .1 All risers must be covered to prevent the entry of debris into the duct.
- .5 Downward Facing and Horizontal Duct Openings
 - .1 Downward facing and horizontal openings will not be required to be covered.
- .6 Access provisions for On-Going Maintenance
 - .1 The specifier shall define the size, location and type of access opening required for maintenance of the system.
- .7 Access Openings to In-Duct Plant
 - .1 Access covers shall be firmly fitted in position on completion of each section of the work.
- .3 Intermediate Level
 - .1 General
 - .1 In addition to the provisions of the basic level, the following requirements shall also apply.
 - .2 Site Storage
 - .1 The area provided for storage shall be clean, dry and exposure to dust minimized.
 - .3 Installation
 - .1 The working area shall be clean and dry and protected from the elements.
 - .2 The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation.
 - .3 Open ends on completed ductwork and overnight work-in-progress shall be sealed.
- .4 Advanced Level
 - .1 General
 - .1 In addition to the provisions of the intermediate level, the following requirements shall also apply.
 - .2 Production and Site Delivery Requirements

- .1 All self-adhesive labels for part identification are to be applied to external surfaces only.
 - .2 To maintain cleanliness during transportation, all ductwork shall be sealed either by blanking or capping duct ends, bagging small fittings, surface wrapping or shrink wrapping.
 - .3 Site Storage
 - .1 A clean and dry environment where the ductwork is protected from dust must be provided for the storage of ductwork prior to installation.
 - .2 All sealed ends shall be visually examined and if damaged, resealed with an appropriate material.
 - .4 Installation
 - .1 The working area shall be clean, dry and the ductwork protected from dust.
 - .2 Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
- .2 Job Site Cleanup
 - .1 Refer to the Division 01 specifications for job site cleanup requirements
 - .2 Notify the Departmental Representative if job site conditions create a potential for contamination of the duct systems.
 - .3 All interior duct surfaces shall be left smooth, nonporous, and free of obstructions prior to project turn-over.
- .3 Temporary Storage
 - .1 Locate site duct material storage away from high dust generating processes such as masonry or tile cutters, cut-off saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept.
 - .2 Locate site duct material storage away from areas where painting will occur.
 - .3 Storage locations shall include pallets or blocking to keep ductwork above the floor surface.
- .4 Scheduling of Work
 - .1 During start-up operation of the HVAC systems, take special care to protect the return air system by installing temporary filters at the air handling unit.

3.2 DUCT CLEANING

- .1 Refer to Section 23 01 31 – Air System Cleaning for duct cleaning requirements.

3.3 DUCT LEAKAGE

- .1 High Pressure Ductwork
 - .1 Perform testing of leakage in high pressure ductwork in accordance with the Air Duct Leakage Test Report section.

.2 Low Pressure Ductwork

- .1 Inspect all low pressure ductwork for visual or audible signs of leakage paying particular attention to connections of ductwork to grilles, diffusers, or louvers.
- .2 Repair identified leaks regardless of their contribution to total leakage.

3.4 GENERAL

- .1 Do work in accordance with ASHRAE, SMACNA and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with ASHRAE and SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.
- .7 Duct sizes indicated on drawings are clear inside dimensions. Refer to Section 23 07 15 for acoustic duct lining requirements.
- .8 Ensure installation of fire-stopping does not distort duct.
- .9 Site Coordination
 - .1 Coordinate ductwork and ductwork components with the work of other trades.

3.5 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.

3.6 WATERTIGHT DUCTWORK

- .1 Provide watertight duct for:
 - .1 Outside air intake
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 30 mm drain connected, with deep seal trap and trap primer and discharging to open funnel drain.

3.7 SEALING AND TAPING

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

3.8 DUCTWORK CONNECTED TO DUCT-MOUNTED HUMIDIFIERS

- .1 Provide 600mm (minimum) of straight stainless steel ductwork upstream of the duct-mounted humidifier.
- .2 Provide 2,000mm (minimum) of straight stainless steel ductwork downstream of the duct-mounted humidifier.
- .3 Slope the downstream portion of the stainless steel ductwork at 2% grade (in both direction) towards a drain located 600mm downstream of the humidifier section.
- .4 Coordinate the location of the duct-mounted humidifier and associated stainless steel ductwork and drain to ensure that the drain and entire length of the interior of the ductwork is accessible.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section including:
 - .1 Flexible connections
 - .2 Duct access doors
 - .3 Turning vanes
 - .4 Instrument test ports
 - .5 Pressure and temperature ratings
 - .6 Flame spread and smoke ratings (for non-metallic products)

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Submittal Format
 - .1 In addition to the general requirements for Shop Drawing submittals indicated in Section 20 00 01 - Common Work Results - Mechanical, indicate the following:
 - .1 Pressure and temperature rating
 - .2 Flame spread and smoke development ratings
- .3 Submittal Procedure
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results – Mechanical and Division 01.
 - .2 Include a copy of each shop drawing in the Operation and Maintenance Manuals.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manual Content from this Section
 - .2 As-Built Markups containing information from this Section

1.5 CONTRACTOR AS-BUILT DRAWING MARK-UP REQUIREMENTS

- .1 Submittal Format
 - .1 In addition to the general requirements for Contractor As-Built Drawing Markups indicated in Common Work Results - Mechanical, indicate the following:
 - .1 Location of instrument test ports
 - .2 Location of access doors and installed sizes

Part 2 Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame
 - .1 Galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 deg C to plus 90 deg C, density of 1.3 kg/m2.

2.3 DUCT ACCESS PANELS

- .1 Non-Insulated Ducts
 - .1 Sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts
 - .1 Sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets
 - .1 Neoprene
- .4 Hardware
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
- .5 Size
 - .1 Service Entry: 450 x 350 mm where duct size permits
 - .2 Viewing: 300 x 200 mm

- .3 Body Entry: 1200 x 900 mm

2.4 TURNING VANES

- .1 Factory or shop fabricated single thickness, full radius, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture
- .2 Cam lock handles with neoprene expansion plug and handle chain
- .3 28 mm minimum inside diameter. Length to suit insulation thickness
- .4 Neoprene mounting gasket
- .5 Acceptable Material: Duro Dyne IP2

2.6 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper
- .2 Sheet metal thickness to co-responding round duct standards

Part 3 Execution

3.1 FLEXIBLE CONNECTIONS

- .1 Install flexible connections in following locations:
 - .1 Inlets and outlets to fans
 - .2 Inlets and outlets of air handling units
 - .3 As indicated
- .2 Length of connection: 100 mm
- .3 Minimum distance between metal parts when system in operation: 75 mm
- .4 Install in accordance with recommendations of SMACNA
- .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment
 - .2 Ensure slack material in flexible connection

3.2 INSTRUMENT TEST PORTS

- .1 General
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .2 Locate to permit easy manipulation of instruments.
- .3 Install insulation port extensions as required.
- .4 Locations

- .1 For traverse readings:
 - .1 Inlets and outlets of fan systems
 - .2 And as indicated
- .2 For temperature readings:
 - .1 At outside air intakes
 - .2 In mixed air applications in locations as approved by Departmental Representative
 - .3 At inlet and outlet of coils (except duct or terminal unit mounted reheat coils)
 - .4 Downstream of junctions of two converging air streams of different temperatures
 - .5 And as indicated

3.3 TURNING VANES

- .1 Install in accordance with recommendations of SMACNA and as indicated.

3.4 DUCT ACCESS PANELS

- .1 Provide access doors for the inspection of duct-mounted components and cleaning of duct systems.
- .2 Where duct size permits, access doors shall be at least 450x350mm.
- .3 Access doors shall have an effective seal (i.e. no air leakage) and latching or level mechanisms.
- .4 Coordinate access points with other trades to provide unimpeded access.
- .5 Provide duct access panels in the following locations:
 - .1 In front and behind turning vanes, silencers, and duct-mounted coils
 - .2 At the top and bottom of vertical ducts having multiple floor penetrations
 - .3 At fire, smoke, and motorized dampers
 - .4 At locations having an internally mounted piece of equipment or device
 - .5 In fresh air ducts near intake louvers
 - .6 At equipment requiring maintenance
 - .7 Such that any section of duct is not more than 15m from a point of access
 - .8 Such that any section of duct downstream of a HEPA filter is not more than 3 m from a point of access
 - .9 Where required by code

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 10 – Common Work Results – Mechanical indicate the following:
 - .1 Pressure and temperature rating
 - .2 Leakage rating

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.5 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 10 – Common Work Results - Mechanical.

1.6 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements

- .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of all dampers

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

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

2.3 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm.
- .4 Bearings:
 - .1 Up to 300mm blade width: self-lubricating nylon
 - .2 Over 300mm blade width: pin in bronze bushings.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 INSTALLATION

- .1 Install where indicated and specified herein.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Run-outs to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .4 Dampers: vibration free.

.5 Ensure damper operators are observable and accessible.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 10 – Common Work Results – Mechanical indicate the following:
 - .1 Pressure and temperature rating
 - .2 Leakage rating

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.5 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 10 – Common Work Results - Mechanical.

1.6 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements

- .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of all operating dampers and location of associated operators

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 Non-insulated dampers: Ruskin, Tamco, Westvent.
- .2 Insulated dampers: Ruskin, Tamco, Westvent.
- .3 Insulated thermally-broken dampers: Tamco.

2.2 NON-INSULATED DAMPERS

- .1 Configuration:
 - .1 Mixing dampers: parallel blade
 - .2 Modulating capacity control: opposed blade
 - .3 Open/Close: parallel blade
 - .4 Isolation: parallel blade
- .2 Aluminum airfoil frames and blades shall be extruded aluminum with thickness of 2.0 mm minimum.
 - .1 Blades shall be of single unit airfoil design 150 mm wide.
- .3 Frames shall be extruded aluminum channel with grooves for vinyl seals.
 - .1 Standard frames: 50 mm x 100 mm x 15.9 mm on linkage side, 25 mm x 100 mm x 25 mm on the other 3 sides.
- .4 Pivot rods shall be 22 mm hexagon extruded aluminum interlocking into blade section.
 - .1 Bearings shall be of a double sealed type with a Celcon inner bearing on rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.
- .5 Bearing shall be designed so that there is not metal-to-metal contact or metal-to-bearing riding surfaces.
 - .1 Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linking.
- .6 Blade linkage hardware shall be installed in frame out of air stream.
 - .1 All hardware shall be of non-corrosive reinforced material of cadmium-plated steel.
- .7 Damper seals shall be designed for minimum air leakage by means of overlapping seals.
- .8 Jackshaft assemblies shall be provided for multiple damper installations.
- .9 Acceptable material: T. A. Morrison, Tamco series 1000.

2.3 INSULATED DAMPERS

- .1 Opposed or parallel blade type.
- .2 Performance:
 - .1 Leakage: in closed position to be less than 20 L/s per m² at 1000 Pa differential across damper.
 - .2 Pressure drop: at full open position to be less than 3 Pa differential across damper at 2 m/s.
- .3 Aluminum airfoil frames and blades shall be extruded aluminum with thickness of 2.0 mm minimum. Blades shall be of single unit air foil design 150 mm wide insulated with extruded polystyrene foam.
- .4 Frames shall be extruded aluminum channel insulated with extruded polystyrene foam with grooves for seals. Standard frames: 50 mm x 100 mm x 15.9 mm on linkage side, 25 mm x 100 mm x 25 mm on the other 3 sides.
- .5 Pivot rods shall be 22 mm hexagon extruded aluminum interlocking into blade section. Bearings shall be of a double sealed type with Celcon inner bearing on rod within a polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.
- .6 Bearing shall be designed so that there is not metal to metal contact or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linking.
- .7 Blade linkage hardware shall be installed in frame out of air stream. All hardware shall be of non-corrosive reinforced material of cadmium plated steel.
- .8 Damper seals shall be EPDM material designed for minimum air leakage by means of overlapping seals.
- .9 Jack shaft assemblies shall be provided for multiple damper installations.
- .10 Acceptable material: T. A. Morrison, Tamco series 9000.

2.4 INSULATED THERMALLY BROKEN DAMPERS

- .1 Opposed or parallel blade type.
- .2 Performance:
 - .1 Leakage: in closed position to be less than 25 L/s per m² at 1000 Pa differential across damper at -40 deg. C.
 - .2 Pressure drop: at full open position to be less than 3 Pa differential across damper at 2 m/s.
- .3 Aluminum airfoil frames and blades shall be extruded aluminum with thickness of 2.0 mm minimum. Blades shall be of single unit air foil design 150 mm wide insulated with extruded polyurethane foam.
- .4 Frames shall be extruded aluminum channel insulated with extruded polystyrene foam and thermally broken by polyurethane. Standard frames: 50 mm x 100 mm x 15.9 mm on linkage side, 25 mm x 100 mm x 25 mm on the other 3 sides.

- .5 Pivot rods shall be 22 mm hexagon extruded aluminum interlocking into blade section. Bearings shall be of a double sealed type with Celcon inner bearing on rod within a polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.
- .6 Bearing shall be designed so that there is not metal-to-metal contact or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linking.
- .7 Blade linkage hardware shall be installed in frame out of air stream. All hardware shall be of non-corrosive reinforced material of cadmium plated steel.
- .8 Damper seals shall be silicone material designed for minimum air leakage by means of overlapping seals.
- .9 Jackshaft assemblies shall be provided for multiple damper installations.
- .10 Acceptable material: T. A. Morrison, Tamco series 9000BF.

2.5 OPERATOR

- .1 By Division 25 EMCS Contractor.

Part 3 Execution

3.1 INSTALLATION

- .1 Install insulated dampers at the following locations:
 - .1 Louvers for systems serving stairwells
 - .2 Air intake and exhausts
 - .3 Where indicated
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Ensure dampers are observable and accessible.

END OF SECTION

Part 1 General

1.1 REFERENECE STANDARDS

- .1 Not used.

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Shop Drawings
 - .1 Provide Contractor and Departmental Representative-reviewed Shop Drawings for each product of this section.
 - .2 In addition to the general requirements for Shop Drawing submittals, indicate the following:
 - .1 Capacity
 - .2 Throw and terminal velocity
 - .3 Noise criteria
 - .4 Pressure drop
 - .5 Neck velocity
 - .6 Security and attachment

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Operations and Maintenance Manuals
 - .1 Include the following documentation in the Operations and Maintenance Manuals as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section).
 - .1 Commissioning Reports
 - .1 As required by Section 20 30 03 – Mechanical Commissioning
 - .2 Shop Drawings
 - .1 Provide Contractor and Departmental Representative-reviewed Shop Drawings for each product of this section.
 - .3 Maintenance Data
 - .1 Provide Manufacturer's start-up, installation, and troubleshooting instructions for each product of this section
 - .2 Provide a list of spare parts recommended by the Manufacturer for each product of this section.
 - .4 System Demonstration and Training
 - .1 Provide documentation used during System Demonstration and Training for all products/systems related to this section.
- .3 As-Built Drawings

- .1 Indicate the following specific information on the Contractor's marked-up As-Built Drawings as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section). This list is not intended to define all of the information required to be shown on As-Built drawings but rather to remind the Contractor to show commonly-missed items.
 - .1 Location of:
 - .1 Balancing dampers
- .4 Spare Parts
 - .1 Provide the following spare parts as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section).
 - .1 Filters: One (1) filter for each grille containing an integral filter (in addition to the final filter at time of turnover to the Owner)
 - .2 Volume Control Adjustment Keys: One (1) volume control adjustment key for each volume control adjustment type
 - .3 Air Flow Pattern Adjustment Keys: One (1) air flow pattern adjustment key for each air flow adjustment key control adjustment type

1.4 CERTIFICATIONS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

- .1 Type as indicated on schedule on drawings.
- .2 To meet construction, material, capacity, pressure drop, terminal velocity, throw, noise level, neck velocity standards set by acceptable material indicated in equipment schedule on drawings.
- .3 Diffusers, grilles, and register cores shall be removable for cleaning.
- .4 Frames:
 - .1 Full perimeter gaskets.
 - .2 Concealed fasteners.
- .5 Fastening:
 - .1 Exposed ductwork: screw grille or diffuser to ductwork.

- .6 Concealed manual volume control damper operators.
- .7 Material: Aluminum with aluminum volume control dampers unless otherwise indicated.
- .8 Color: manufacturer's standard off white unless otherwise indicated.

2.3 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY, RETURN, AND EXHAUST GRILLES, SECURITY

- .1 Single deflection airflow pattern using 45 degree bent louvers.
- .2 Steel construction with steel opposed blade volume control damper.
- .3 Tamper proof security screw fastening.

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 diffuser, register and grille installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with cadmium plated or painted head screws unless noted otherwise in countersunk holes where fastenings are visible.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- .3 National Research Council Canada (NRC)
 - .1 National Building Code of Canada (NBC)
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .5 Society of Automotive Engineers (SAE)

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Shop Drawings
 - .1 Provide Contractor and Departmental Representative-reviewed Shop Drawings for each product of this section.
 - .2 In addition to the general requirements for Shop Drawing submittals, indicate the following:
 - .1 Pressure drop through at measured velocity
 - .2 Face area
 - .3 Free area
 - .4 Installation details
 - .5 Finish

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Operations and Maintenance Manuals
 - .1 Include the following documentation in the Operations and Maintenance Manuals as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section).
 - .1 Commissioning Reports
 - .1 As required by Section 20 30 03 – Mechanical Commissioning
 - .2 Certificates
 - .1 Provide certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E 90.
 - .3 Shop Drawings

- .1 Provide Contractor and Departmental Representative-reviewed Shop Drawings for each product of this section.
 - .4 Maintenance Data
 - .1 Provide Manufacturer's start-up, installation, and troubleshooting instructions for each product of this section
 - .2 Provide a list of spare parts recommended by the Manufacturer for each product of this section.
 - .5 System Demonstration and Training
 - .1 Provide documentation used during System Demonstration and Training for all products/systems related to this section.
- .3 Spare Parts
 - .1 Provide the following spare parts as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section).
 - .1 Filters: One (1) spare filter array for each louver, intake, or vent assembly containing a filter

1.4 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 FIXED LOUVRES – GENERAL USE

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: 12 ga. extruded aluminum alloy 6063-T5.
- .3 Blade: storm-proof pattern with drainable blade, reinforcing bosses and maximum unsupported blade length of 1000 mm.
- .4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit .
- .5 Mullions: concealed back mounted at 1000 mm maximum centres.
- .6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

- .7 Screen: 25 mm mesh, 2 mm diam wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: clear anodized.
- .9 Acceptable material: Price ZE439.

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 louvres, intakes and vents installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.
- .4 Install louvers and connected ductwork to allow moisture within the louver plenum to drain to the outdoors, through the louver by gravity.

END OF SECTION

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 430, Performance Rating of Central Station Air-Handling Units
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
 - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
 - .2 ANSI/ASHRAE/IES 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings
- .3 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 15, Safety Standard for Refrigeration Systems
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section.

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 10 – Common Work Results – Mechanical indicate the following:
 - .1 Capacities
 - .2 Sound Power Levels
 - .3 Fans
 - .4 Filters
 - .5 Fan curves showing operating point (for all control modes)
 - .6 Motor drive
 - .7 Dampers
 - .8 Mixing box
 - .9 Bearings
 - .10 Coils

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Spare Parts

1.5 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section into the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.6 SPARE PARTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Provide spare parts for this Section as follows:
 - .1 Filters Elements: One (1) set of filter elements for each filter bank for each air handling unit (in addition to the final filter elements installed in all filter banks at the time of turnover)

1.7 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.

Part 2 Products

2.1 GENERAL

- .1 Factory assembled components to form units supplying air at designed conditions, as indicated.
- .2 Certify ratings: to ANSI/AHRI 430 with AHRI seal.
- .3 Horizontal type, having air-tight modular components, consisting of casing with:
 - .1 Supply Fan Section (with motor and drive(s))
 - .2 Blender Air Mixing Device
 - .3 Heating Coil
 - .4 Dampers
 - .5 Filter Section
 - .6 Mixing Box Section

UNIT CONSTRUCTION

.1 Standard Construction Units: (Tag: AS-8)

- .1 Unit casing shall be of minimum 18 gauge (1.3 mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.
- .2 All high pressure (5" w.c. (1250 Pa) to 9" w.c. (2250 Pa)) fan sections shall be constructed of 14 gauge (2.0 mm) metal. Continuous high pressure sealant shall be provided between all panels.
- .3 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
- .4 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums and humidifiers/wet cells, electrical control panels, burner compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
- .5 Units shall be provided with hinged access doors, with e-profile gasket, fully lined, and a minimum of two lever handles, operable from both sides for all units.

Hinged access doors open outwards on all sections for outdoors units. Doors located on sections with positive pressure shall have a clear warning label and a safety device must be affixed.

Hinged access doors in welded steel frames. Doors shall be fully lined, come complete with bulb trim seal gasket and lever handles, operable from both sides.

Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label and safety chain must be affixed.

- .6 All units shall be internally insulated with 1"(25mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density insulation.
- .7 1 1/2 lb./cu.ft. (24 kg/cu.m.) insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. Drain pans and all floor areas shall be insulated on the underside.
- .8 Unit casing floors in walk in sections shall be fabricated with 14 ga. (2.0mm) checker plate steel with rust resistant coating, Provide reinforcing channels under floor to minimize deflection.
- .9 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 1"(25mm) galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2" (51mm)

with three break interlocking design; outer wall panels extend a minimum of ¼”(6mm) below the floor panel; drain trap(s) connections for field supply and installation of drain traps.

Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.

Units shall be provided with optional channel flashing constructed of 22 gauge (.85mm) galvanized steel, painted to match unit.

- .2 Lightweight Aluminum Construction Units: (Tag: AS-1, AS-2, AS-6, AS-7, MAU-1)
 - .1 Unit casing shall be of minimum 14 gauge (0.063”) 3003 series aluminum. All unprotected metal and welds shall be factory coated.
 - .2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
 - .3 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums and humidifiers/wet cells, electrical control panels, burner compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
 - .4 Units shall be provided with hinged access doors, with e-profile gasket, fully lined, and a minimum of two lever handles, operable from both sides for all units.

Hinged access doors open outwards on all sections for outdoors units. Doors located on sections with positive pressure shall have a clear warning label and a safety device must be affixed.

Hinged access doors in welded aluminum frames. Doors shall be fully lined, come complete with bulb trim seal gasket and lever handles, operable from both sides.

Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label and safety chain must be affixed.
 - .5 All units shall be internally insulated with 1”(25mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density insulation.

1 1/2 lb./cu.ft. (24 kg/cu.m.)insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. Drain pans and all floor areas shall be insulated on the underside.
 - .6 Unit casing floors in walk in sections shall be fabricated with 14 ga. (0.063”) aluminum, Provide reinforcing channels under floor to minimize deflection.

- .7 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 1"(25mm) galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2" (51mm) with three break interlocking design; outer wall panels extend a minimum of ¼"(6mm) below the floor panel; drain trap(s) connections for field supply and installation of drain traps.

Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.

- .8 Indoor suspended units shall be provided with ½"(13mm) holes in the base channels to accommodate hanger rods (rods supplied by others).

2.3 FANS

.1 General

- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
- .2 Single low pressure forward curved fans of 18" (457mm) or less diameter, shall be equipped with permanently lubricated cartridge ball bearings, supported by a 3 point "spider" bearing bracket in the fan inlets. All other forward curved fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.
- .3 Drives shall be adjustable on fans with motors 7 1/2 HP (5.6 kW) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
- .4 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9" (230mm) to 15" (380mm) diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25mm) static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
- .5 Provide single extended grease line from far side to access side bearing.
- .6 Provide fan scroll access doors and drains.
- .7 Fan motors shall be Super-E high efficiency ODP type.

2.4 GAS HEAT SECTION - Indirect Fired

.1 General

- .1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.
- .2 All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire operation.
- .3 Operating natural gas pressure at unit(s) manifold shall be 7"w.c. (1750 Pa).
- .4 Gas fired units shall be approved for operation in -40 °F (-40 °C).
- .2 Heat Exchanger/Burner Assembly
 - .1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1"(25mm) of insulation between the outer cabinet and inner heat reflective galvanized steel liner. Blower location shall be engineered to improve the required air flow pattern around the heat exchanger. Using duct type furnaces and closed coupled blowers are not acceptable.
 - .2 The heat exchanger/burner assembly shall be a blow through positive pressure type. Units shall have an interrupted pilot ignition system to provide increased safety. Units using continuous or intermittent pilots are not acceptable.
 - .3 Flame surveillance shall be from the main flame after ignition not the pilot flame. The burner and gas train shall be in a cabinet enclosure. Atmospheric burners or burners requiring power assisted venting are not acceptable.
 - .4 The heat exchanger/burner assembly shall include 15:1 turndown for all input ranges from 100 MBH to 1400 MBH (29.3 kW to 410 kW). The high turn down heat exchanger/burner assembly minimum input shall be capable of controlling 6.7% of its rated input, excluding the pilot assembly, without on/off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from high to low fire.
- .3 Factory testing of indirect fired gas heating section.
 - .1 The minimum test requirements on all cabinet / fan size / fan type / fan orientation / heat exchanger / outlet configuration combinations previously built are listed below.
 - .2 Tests shall be performed after complete final unit assembly, just prior to shipping to job site. The tests shall be performed in accordance with the equipment standard that the gas heating section is certified.
 - .1 Heat exchanger shall be clocked with a dedicated calibrated gas meter to insure proper set up of the gas manifold.
 - .2 High and Low input flue gas combustion analysis using a calibrated combustion analyzer including O₂ and CO to provide proper air fuel ratio throughout the entire operating range.
 - .3 A copy of the combustion test report shall be provided.

- .3 Any previously untested combination of cabinet / fan size / fan type / fan orientation / heat exchanger / outlet orientation and all duct furnaces shall have the following additional tests performed.
- .4 Any single component or size or type or orientation change requires these tests. The tests shall be performed with standard factory temperature air, not design temperature air, through the unit as an additional heat exchanger safety factor.
 - .1 Heat Exchanger airflow pattern shall be tested to ensure uniform airflow across all parts of the heat exchanger.
 - .2 Once the equilibrium operating temperatures have been reached, the heat exchanger temperatures shall be checked to ensure that all surfaces are below 1075 °F (579.4 °C). Temperatures above this can lead to premature heat exchanger failure.
 - .3 Flue gas temperature and combustion analysis shall be performed. The heat exchanger efficiency shall be analyzed and must meet current requirements.
 - .4 High limit operational check shall be performed to ensure proper function at all normal airflows including loaded filters.
 - .5 If the unit is capable of or intended to operate at varying air flows, all of the above tests must be performed at high flow and low flow.
 - .6 A copy of the test report shall be provided.
- .4 Venting
 - .1 Installation and venting provisions must be in accordance with CAN/CSA Standard B149.1, ANSI Z223.1-NFPA 54, and local authorities having jurisdiction. Type A, L, and/or PS venting is required on DJE and DJS indoor units.
 - .2 Optional indoor unit manufacturer supplied draft hoods for field installation to accommodate "B" type venting. "B" vent sizing must be in accordance with CAN/CSA Standard B149.1, ANSI Z223.1-NFPA 54, and local authorities having jurisdiction.
 - .3 Unit(s) requiring sidewall venting shall be CETL, ETLUS approved for use with a sidewall venter. The sidewall venter shall be supplied by the unit manufacturer. The unit manufacturer must also supply the air proving switch, wall cap, double acting barometric damper, and all necessary control interlocks.
- .5 Outdoor venting when installed close to a parapet or wall.
 - .1 Venting is to be provided by the installing contractor using materials approved for outdoors. Installation and venting provisions must be in accordance with CAN/CSA Standard B149.1, ANSI Z223.1-NFPA54 and local authorities having jurisdiction. Where flue requirements exceed 6" (150 mm) above the unit casing height, it is the installing contractor's responsibility to provide and install venting including all structural-supporting requirements. Support is to be independent of the unit.
- .6 Controls
 - .1 Electronic module (Modulating Fuel w/ Modulating Combustion Air) complete with proportional and integral control with discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge

- air temperature. Combustion air motor speed varies proportionally in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions. Combustion blower RPM shall be proved using a hall effect speed sensor. Two speed or step speed combustion blowers are not acceptable.
- .2 Combustion efficiency of high efficiency heat exchangers shall increase by up to 1-3% from high fire to low fire while turning down on units incorporating 15:1 turndown. Heat exchangers shall provide a minimum of 80% efficiency throughout the entire operating range.
- .3 Alternate manufacturers units that do not incorporate a variable speed combustion air blower shall have a modulating gas valve and a combustion air damper with a linear linkage connected to an actuator which has a minimum of 100 steps of control.
- .4 Controllers for heating only units incorporating the DJM3 module shall include the following standard features:
- .1 Service analyzer with diagnostic lights for ease of set-up and service
 - .2 linear gas and combustion air flow obtained via a built in solid-state linear algorithm
 - .3 -40 °F (-40 °C) minimum operating ambient temperature
 - .4 four air change pre-purge on units with over 400 MBH (117kW) input
 - .5 maintained purge to decrease temperature cycles
 - .6 post purge
 - .7 interrupted pilot
 - .8 self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances
 - .9 low fire start
 - .10 controlled burner start-up and shut down
 - .11 blower contactor that starts fan after burner prepurge
 - .12 economizer enable control
 - .13 damper contact that allows fan to start after damper opens, damper to close after fan stops, and damper to close on flame failure
 - .14 non-recycling auto by-pass low limit with alarm contacts and built-in sensor checking
 - .15 built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation using a single room thermostat
 - .16 separate gas and air actuators independently controlled to give the correct air to fuel ratio though out the entire firing range.
- .5 Heating control function shall be 0-10 VDC BMS reset. Minimum discharge air set point is 50 °F (10 °C) if BMS control signal fails.
- .6 Controllers for heating only units to incorporate low limit feature.
- .7 Discharge air sensor shall be field mounted in supply ductwork by installing contractor.
- .8 Provide a make up air reverse airflow high limit switch in series with the standard high limit switch mounted in the blower discharge.

2.5 FILTERS

.1 General

- .1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.
- .2 For units with filter banks up to 72" (1825 mm) high, the filter modules shall be designed to slide out of the unit. Side removal 1" (25 mm) or 2" (50 mm) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- .3 2"(50mm) Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Permanent re-usable metal enclosing frame. The filter media shall have an average efficiency of 80-85% on ASHRAE 52.1-92 and a MERV of 13 when tested under ASHRAE 52.2.
- .4 Where filters are provided in air handling units for make-up air applications and where hoar frost may occur, only steel frame filters are acceptable. Where indicated, units shall have both summer (upstream of heating coil or gas heat exchanger) and winter (downstream of heating coil or gas heat exchanger) filter sections. Only one set of filters is installed depending on ambient conditions.
- .5 Filter media shall meet UL Class 2 standards.
- .6 Provide filter bank with "Dwyer 2000 magnehelic" air filter gauge complete with static pressure tips and aluminum tubing all factory installed. Filter gauge to have a range of 0 to 1" (0-250 Pa). Where two or more filter banks are connected to a single gauge, a multiple gauge kit with manual shut-off cocks in the air tubing shall be provided.
- .7 Where the filter gauges are provided on outdoor units they shall be mounted inside of a weatherproof enclosure with viewing window.

2.6 DAMPERS

.1 General

- .1 Damper frames shall be U-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2" (13mm) aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.
- .2 Dampers shall be extruded aluminum low leak airfoil.
- .3 Mixing dampers shall be parallel blade type.
- .4 Mixing Box Controls shall provide an adjustable high ambient set back thermostat, temperature controller, and relay to return the outside air damper to the minimum setting when the outdoor ambient temperature rises above 59°F(15°C).

2.7 FACTORY SUPPLIED CONTROLS/WIRING

.1 General

- .1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.
- .2 Gas fired units shall also include high limit and combustion airflow switch.
- .3 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.
- .4 Factory installed and wired non-fused disconnect switch in CEMA/NEMA 1 configuration, or disconnect with integral door closure mounted on face of control panel.
- .5 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.
- .6 Provide an automatic recycling low limit to shut down fan and close the outside air dampers on a heating system failure. This device will automatically recycle the system when the temperature rises above its set point. (Do not use on medium to high % of outside air applications).

Part 3 Execution

3.1 INSTALLATION

- .1 Install units in accordance with manufacturer's instructions and as indicated.
- .2 Ensure adequate clearance for servicing and maintenance.

3.2 FANS

- .1 Install fan sheaves required for final air balance.
- .2 Install vibration isolators.

3.3 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA)
 - .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE)
 - .1 ANSI/IEEE 260.1, 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, BACNET - Data Communication Protocol for Building Automation and Control Network
- .4 Canadian Standards Association (CSA)
 - .1 CAN/CSA-Z234.1, Canadian Metric Practice Guide
- .5 Consumer Electronics Association (CEA)
 - .1 CEA-709.1, Control Network Protocol Specification
- .6 Department of Justice Canada (DJUSC)
 - .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, Light Grey Colour for Indoor Switch Gear
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)
- .9 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34

1.2 DEFINED TERMS

- .1 The definitions of this section are not meant to supersede definitions of the Building Code, Standards, or Contract documents and apply only to these Contract Documents.
- .2 *Downtime* means 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.
- .3 *Points* may be logical or physical.
 - .1 Logical Points
 - .1 Values calculated by system such as set-points, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
 - .2 Physical Points
 - .1 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.
- .4 *Point Names* are composed of two parts, point identifier and point expansion.
 - .1 Point Identifier
 - .1 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 short-forms or acronyms. Database must provide [25]character field for each point identifier.
 - .2 Point Expansion
 - .1 Comprised of three fields, one for each descriptor. Expanded form of short-form 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.

- .5 *Point Object Types* fall into the following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .6 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.
 - .2 Refer also to Section [25 05 54- EMCS: Identification].

1.3 ABBREVIATIONS

- .1 AEL - Average Effectiveness Level
- .2 AI - Analog Input
- .3 AIT - Agreement on International Trade
- .4 AN – Application Node
- .5 ANSI – American National Standards Institute
- .6 AO - Analog Output
- .7 BACnet - Building Automation and Control Network
- .8 BC(s) - Building Controller(s)
- .9 BECC - Building Environmental Control Centre
- .10 BIBB – BACnet Interoperability Building Block
- .11 BMS – Building Management System (same meaning as EMCS)
- .12 CAD - Computer Aided Design
- .13 CCS – Central Control System
- .14 CDL - Control Description Logic
- .15 CD-R – Writable Compact Disk
- .16 CD-RW – Rewritable Compact Disk
- .17 CDS - Control Design Schematic
- .18 COSV - Change of State or Value
- .19 CPU - Central Processing Unit
- .20 DDC – Distributed Digital Control
- .21 DI - Digital Input
- .22 DO - Digital Output
- .23 DP - Differential Pressure
- .24 ECU - Equipment Control Unit

- .25 EEPROM – Electrically Erasable Programmable ROM
- .26 EPROM – Ultraviolet Erasable Programmable ROM
- .27 EMCS - Energy Monitoring and Control System (same meaning as BMS)
- .28 GUI – Graphical User Interface
- .29 HOA – Hand-Off Auto
- .30 HVAC - Heating, Ventilation, Air Conditioning
- .31 IDE - Interface Device Equipment
- .32 I/O - Input/Output
- .33 ISA - Industry Standard Architecture
- .34 LAN - Local Area Network
- .35 LonMark – LonWorks devices certified by the LonMark Interoperability Association
- .36 LonWorks – ANSI/EIA 709.1 Control Networking Standard
- .37 LCU - Local Control Unit
- .38 MCU - Master Control Unit
- .39 NAFTA - North American Free Trade Agreement
- .40 NC - Normally Closed
- .41 NO - Normally Open
- .42 OS - Operating System
- .43 O&M - Operation and Maintenance
- .44 OWS - Operator Work Station
- .45 PC - Personal Computer
- .46 PCI - Peripheral Control Interface
- .47 PCS – Portable Control Station
- .48 PCMCIA - Personal Computer Micro-Card Interface Adapter
- .49 PID - Proportional, Integral and Derivative
- .50 RAM - Random Access Memory
- .51 SP - Static Pressure
- .52 SPDT – Single Pole Double Throw
- .53 SPST - Single Pole Single Throw
- .54 ROM - Read Only Memory
- .55 RCU – Remote Control Unit
- .56 TCP/IP – Transmission Control Protocol / Internet Protocol
- .57 TCU - Terminal Control Unit
- .58 UCL – User Control Language

- .59 USB - Universal Serial Bus
- .60 UPS - Uninterruptible Power Supply
- .61 VAV - Variable Air Volume
- .62 WAN – Wide Area Network

1.4 INTENT

- .1 This Section specifies the specific requirements for the work of Division 25 supplemented by the general requirements of Divisions 0, 1, 20, 21, 22, and 23.
 - .1 Refer to Section 20 00 01 – Common Work Results for general format and submissions requirements for:
 - .1 Samples
 - .2 Mock-Ups
 - .3 Information Documents
 - .4 Shop Drawings
 - .5 Test Reports
 - .6 Manufacturer's Equipment Start-Up Reports
 - .7 Certification Reports
 - .8 Operation and Maintenance Manuals
 - .9 Contractor As-Built Documents
 - .10 Spare Parts
 - .11 Contractor's Warranty
 - .12 System Demonstration and Training
 - .13 Substantial Performance
 - .2 Mechanical Division Contract Documents
 - .1 The mechanical Division contract documents shall be read in conjunction with the manufacturer's installation instructions.
 - .2 The Mechanical Contract Documents are copyright and may not be reproduced without the explicit written permission of SNC-Lavalin.
 - .3 Mechanical Drawings
 - .1 The mechanical drawings are not detailed installation instructions and do not show every pipe or duct elbow, fitting, valve, or system component required by the specifications or show the exact required routing of the services unless specifically indicated.
 - .2 The intended purpose of the mechanical drawings is to show, graphically, quantities and locations of tagged equipment, and how the products interface with other materials and products.
 - .3 The mechanical drawings are diagrammatic and only approximately to scale even when scales are indicated. Do not scale from the mechanical drawings in order to determine dimensions or distances.
 - .4 Mechanical Specifications

- .1 The intent of the mechanical specifications is to define the quality and types of materials and workmanship upon which the contract is based.
- .2 The mechanical specifications shall be read in conjunction with the mechanical drawings.
- .3 Where codes or standards are referenced in the mechanical specifications, conform to the date or version of the code or standards referenced by the provincial building code in effect at the time of the submission of bids unless a specific date or edition is referenced.
- .5 Contract Document Discrepancies
 - .1 Review the entire set of contract documents (i.e. drawings and specifications of all Divisions) prior to bidding on the work.
 - .2 Where a discrepancy exists (regardless of where it appears in the entire set of contract documents):
 - .1 Submit a formal request for clarification during the tendering phase.
 - .2 If a formal request for clarification was not submitted, or if there is insufficient time for the Departmental Representative to clarify the design intent by means of an Addendum, include the cost for the MOST expensive definition of the work inclusive of all affected trades.
 - .3 The Departmental Representative reserves the right to clarify the design intent regardless of when or what stage of construction the discrepancy is identified.
 - .4 Work that has taken place relating to the discrepancy without first requesting clarification to determine the design intent is subject to removal and replacement at no additional cost if the Departmental Representative determines the alternate definition of the scope of work to be correct once the discrepancy is identified.

1.5 SUSTAINABILITY REQUIREMENTS

- .1 Refer to Section 20 00 01 – Common Work Results – Mechanical for Sustainability Requirements.

1.6 GENERAL REQUIREMENTS

- .1 Construction Schedule
 - .1 Comply with requirements of Division 01.
 - .2 Include EMCS installation schedule as part of the construction progress schedule.
 - .3 Include start and finish dates for:
 - .1 Equipment ordering and delivery
 - .2 Hardware installation
 - .3 Start-up and point calibration
 - .4 Software loading and testing
 - .5 System testing
 - .6 Commissioning
 - .4 Coordinate EMCS schedule with construction schedule.

- .2 Construction Progress Meetings
 - .1 Comply with requirements of Division 1.
- .3 Bid Submissions
 - .1 Comply with the requirements of Divisions 0 and 1 and the following:
 - .1 Submit , with bid, a drawing of EMCS system architecture identifying each controller type, server, central control station, remote control station, each communication network and communication protocol for each network.
- .4 Product Options and Substitutions
 - .1 Refer to Section 20 00 01 – Common Work Results – Mechanical for Product Options and Substitution requirements.
 - .2 EMCS package shall be comprised of only the most recent technology product lines from each pre-qualified bidder.

1.7 SPECIFIC SCOPE REQUIREMENTS

- .1 The EMCS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned EMCS.

1.8 SYSTEM DESCRIPTION

- .1 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.
- .2 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 Departmental Representative prior to installation.
 - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
 - .4 Provide utility power to EMCS and emergency power to EMCS.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.
 - .6 Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification.
- .3 Language Operating Requirements:
- .1 Provide English operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible.
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation.
 - .4 System Manager Software
 - .1 Include 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:
 - .1 Input and output commands and messages from operator-initiated functions and field-related changes and 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-definitions).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points at specified OWS and to be able to operate two terminals.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.9 QUALITY ASSURANCE

- .1 Provide and install a fully proven system as described, including field tested hardware, operating system and applications software.
- .2 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .3 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

- .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
- .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
- .3 Submit proof of compliance to specified standards with shop drawings and product data.
 - .1 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
- .4 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.

1.10 INTEGRATION OF NEW CONTROLS WITH EXISTING EMCS SYSTEM

- .1 General Scope of Work
 - .1 The work does not include the replacement of existing pneumatic operated valves or replacement of pneumatic damper actuators.
- .2 Existing System Investigation
 - .1 Conduct and submit an EMCS Integration Report as required by this Section.
- .3 Utilization of Existing Components
 - .1 Utilize existing control wiring and piping where possible and where it meets the requirements of the Division 25 Sections.
 - .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 Departmental Representative.
 - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .4 Assume responsibility for controls to be incorporated into EMCS.
 - .1 Be responsible for items repaired or replaced by Owner.
 - .2 Be responsible for repair costs due to negligence or abuse of equipment.
 - .3 Be responsible for existing devices termination.
- .5 Demolish existing controls not re-used or not required.
 - .1 Place in approved storage for disposal as directed.

1.11 SHOP DRAWINGS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.

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- .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
- .4 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .5 Each Shop Drawing submittal shall include a cover sheet prepared by the submitting Contractor that MUST include the following:
 - .1 Project Name
 - .2 Departmental Representative's Project Number
 - .3 Descriptive title of the Shop Drawing
 - .4 Contractor's Shop Drawing tracking number
 - .5 Number of pages under title page
 - .6 Brief description of Shop Drawing contents (including equipment tags that match those shown on the drawings)
 - .7 Specification Section number relating to the Shop Drawing
 - .8 Name and phone number of Contractor or Sub-Contractor responsible for ensuring that the information contained in the Shop Drawing is compliant with the Contract Documents
 - .9 Name and phone number of the equipment supplier responsible for the technical details of the Shop Drawing who may be contacted by Departmental Representative to discuss the submittal details (Providing this information may prevent the need for a Shop Drawing to be stamped as 'Revise and Resubmit')
 - .10 Contractor's stamp, signed by Contractor's authorized representative certifying review and approval of submissions, verification of field measurements and compliance with Contract Documents
 - .11 A blank area no smaller than 200 mm wide x 125 mm high for exclusive use by Departmental Representative for stamps and review comments
- .6 Shop Drawings shall include the following general information as a minimum in addition to that required by individual Sections:
 - .1 Associated equipment tag and functional descriptor
 - .2 Installation instructions
 - .3 Manufacturer certification of current model production
 - .4 Certification of compliance to applicable codes and standards
 - .5 Required operating and maintenance clearances
 - .6 Detailed drawings of bases, supports, and anchor bolts
 - .7 Performance based on specified set-point parameters
 - .8 Electrical information including (but not limited to): voltage, phase, frequency, full-load amps, horsepower, current, and power factors.
 - .9 Weight and dimensions
- .2 Submittal Procedure

- .1 Submit one (1) copy of each Shop Drawing to the Departmental Representative as required by each Section and for all tagged equipment on the drawings and specifications.
 - .2 Thoroughly review the content of each Shop Drawing and stamp it to indicate it is compliant with the Contract Documents prior to submission to the Departmental Representative. The Contractor's stamp indicates that they have verified that it is in strict accordance with the requirements of the Contract Documents.
 - .3 Allow a minimum of fifteen (15) working days (minimum) prior to the desired return date for the Departmental Representative to circulate the submittals to the appropriate Sub-Departmental Representatives for review.
 - .1 Shop Drawings that indicate a desired return date that is less than the minimum specified amount may not be met by the Departmental Representative.
 - .2 Refrain from submitting a large amount of Shop Drawings over a short period of time or in large groups. If this occurs, the Departmental Representative reserves the right to indicate the required amount of time in order to do a proper review of the Shop Drawings. Adequate time for the Departmental Representative to do a thorough review of the Shop Drawings shall be allowed for in the construction schedule and extensions to the review period shall not be deemed as an unforeseen extension to the construction schedule.
 - .4 Shop Drawings that are not submitted according to the Submittal Procedure, or not in accordance with the Submittal Format, are subject to being returned without review by Departmental Representative. Shop Drawings that are rejected due to a failure to comply with the specification requirements shall be resubmitted allowing the full fifteen (15) working day review period from the date of the re-submittal.
 - .1 The Contractor shall be responsible for submitting Shop Drawings in accordance with the specification requirements in order to not adversely affect the Construction Schedule.
 - .5 Where the Departmental Representative has stamped Shop Drawings as 'Revise and Resubmit', make the required changes and/or provide the requested information and resubmit.
 - .1 Allow an additional ten (10) working days (as a minimum) for the Departmental Representative to do a review of the Revise and Resubmit Shop Drawings.
 - .2 Allow sufficient time in the Construction Schedule for Shop Drawing review including sufficient time for subsequent reviews of Shop Drawings that have been noted as "Revise and Resubmit".
 - .6 Work affected by the content of the Shop Drawings shall not proceed until they have been reviewed by the Departmental Representative and marked as either 'Reviewed' or Reviewed as Noted'.
- .3 Departmental Representative's Review of Shop Drawings

- .1 The Contractor shall be solely responsible for ensuring that that information contained in Shop Drawing submittals (and the installed equipment) is in complete accordance with the Contract Documents.
- .2 The Shop Drawings do not form part of the Contract Documents. Shop Drawings reviewed by the Departmental Representative with or without comments are not an indication that the information contained within meets the requirements of the Contract Documents.
- .3 The purpose of the Departmental Representative's review of the Shop Drawings is to review details and supplemental information about the products and materials being provided by the Contractor to assist in the Departmental Representative's construction reviews and to ensure that proper records of installed equipment are provided.
- .4 The Contractor shall be responsible for correcting any work that is found to be non-compliant with the requirements of the Contract Documents regardless of when the deficiency is identified.
- .5 The Contractor shall be solely responsible for ensuring that where quantities, performance parameters, weights, dimensions, electrical characteristics, control functionality, or other pertinent functionality is different than the base equipment shown in the equipment schedules, the variances do not affect the work or cost of work of other Divisions.
 - .1 Where these variances affect the cost of the work of this or another Division, and the base specified product is not available for a reason beyond the Contractor's control:
 - .1 Attach to the Shop Drawing correspondence explaining why it is not possible to provide equipment that meets all performance parameters/functionality of the base specified equipment. Identify the specific performance parameters/functionality that cannot be met as well as literature/correspondence with suppliers/manufacturers to support this claim.
 - .2 Submit a Shop Drawing for alternate equipment (from approved manufacturers where possible) that best matches the performance criteria for the specified equipment that otherwise meets the requirements of the Contract Documents.
 - .3 Submit a narrative identifying what Divisions will have a cost impact due to the variances of the alternate product.
- .4 Shop Drawing shall include as a minimum:
 - .1 Description of Building Automation System
 - .1 Narrative description of system architecture
 - .2 Network infrastructure schematics
 - .3 Wiring detail schematics that indicate: Cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled
 - .4 Mechanical system schematics
 - .5 Component schedules indicating point ID, system point, equipment tag, quantities, model number, and component description

- .6 Interface wiring diagrams showing termination connections and signal levels for equipment supplied by others
- .7 Written control sequences for each system including:
 - .1 Initial set-point values
 - .2 Initial time-of-day control schedules
- .2 Controllers: complete schedule including the following information:
 - .1 Description of all points associated with each controller
 - .2 Spare point capacity by number and type
 - .3 Locations on plan drawings
- .3 Dampers: including the following information:
 - .1 Sketches showing module assembly
 - .2 Interconnecting hardware
 - .3 Operator locations
 - .4 Operator spring range
 - .5 Pilot range
 - .6 Required torque
 - .7 Actual torque
- .4 Flow measuring stations:
 - .1 Complete schedule listing designation
 - .2 Service
 - .3 Point ID
 - .4 Manufacturer
 - .5 Model
 - .6 Size
 - .7 Velocity at design flow rate
 - .8 Manufacturer
 - .9 Model and range of velocity transmitter
- .5 Sensors and Transmitters
 - .1 Sensing element type and locations
 - .2 Transmitter type and range
 - .3 Associated field wiring schematics, schedules, and terminations
 - .4 Complete Point Name Lists
 - .5 Set-points, 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

1.12 EMCS OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements

- .1 The work of Division 25 shall be incorporated into the EMCS Operation and Maintenance Manual requirements of this Section.
 - .1 The EMCS Operation and Maintenance Manual shall be separate from the Operation and Maintenance Manual required by Section 20 00 01 – Common Work Results – Mechanical.
- .2 Submit EMCS Operation and Maintenance Manuals three times throughout the duration of the project in accordance with Submittal Format below.
- .2 Submittal Format
 - .1 Submittal Content Requirements
 - .1 Submittal #1: Format Review
 - .1 Submittal Format: Indexed .pdf file
 - .2 Submittal Timeline: Submit any time after all information of Section 1 – Mechanical Systems has been prepared
 - .3 Submittal Instructions: Provide placeholders for all other information not included in this submittal
 - .4 Required information:
 - .1 All formatting including cover text for each binder, wording of each tab, and directories
 - .2 All information required by Section 1 – Overview
 - .2 Submittal #2: Pre-TAB Review
 - .1 Submittal Format: Indexed .pdf file
 - .2 Submittal Timeline: Submit a minimum of 15 working days prior to commencement of TAB
 - .3 Submittal Instructions:
 - .1 Information required by any Section may be submitted at this time providing that it is complete
 - .4 Required information:
 - .1 All information from Submittal #1
 - .2 All information required by Section #2
 - .3 All information required by Section #3
 - .3 Submittal #3: Final Submission Review
 - .1 Submittal Format: Indexed .pdf file and one (1) physical copy
 - .2 Submittal Timeline: Submit after acceptance of Substantial Performance
 - .3 Submittal Instructions:
 - .1 Ensure the cover text for each binder has been approved prior to preparing the physical copies
 - .4 Required information:
 - .1 Provide all information required by this Section
 - .2 Physical Copy Assembly Requirements

- .1 Coordinate the style and preparation of the EMCS Operation and Maintenance Manual with the Mechanical Operations and Maintenance Manual
- .2 Prepare using 8-1/2 x 11 inch text pages, expanding post binders with durable green-colour cloth covers connected to spine with piano hinges.
- .3 Prepare binder cover with printed title "OPERATION AND MAINTENANCE MANUAL – EMCS", title of project, and subject matter of binder when multiple binders are required.
- .4 Internally subdivide the binder contents with permanent page dividers, logically organized as described in the format Section below; with tab titling clearly printed on reinforced laminated plastic tabs.
- .5 Provide additional binders as required to store all of the required information.
- .3 General Manual Format
 - .1 Section 1 - Overview
 - .1 Index:
 - .1 Complete EMCS O&M Manual index
 - .2 Directory:
 - .1 Directory listing names, addresses, and telephone numbers the Departmental Representative, all Sub-Departmental Representatives, EMCS Contractor, EMCS Subcontractors, and all equipment suppliers
 - .3 Drawings:
 - .1 List of all EMCS Contract Document Drawings
 - .2 List of all EMCS drawings produced by the EMCS Contractor
 - .2 Section 2 – Tests & Reports
 - .1 Manufacturer's Equipment Start-Up Reports:
 - .1 All Manufacturer's Equipment Start-Up Reports required by each Section
 - .2 System Test Reports:
 - .1 All System Test Reports required by each Section.
 - .3 Certificates
 - .1 Declaration of EMCS Contractor Warranty
 - .2 Declaration of Extended Warranties where required by each Section
 - .3 EMCS Manufacturer's Warranty
 - .4 EMCS Service Contracts provided by the Contractor
 - .5 EMCS Contractor Bond (only when EMCS Contractor is serving as the General Contractor)
 - .3 Section 3 – Product Data
 - .1 Shop Drawings

- .1 All Shop Drawings and product data as required by each Division 25 Section (separate each product with an indexed tab)
- .2 Maintenance Data
 - .1 Installation instructions
 - .2 Servicing, maintenance, operation, and trouble-shooting instructions for each Shop Drawing as appropriate
 - .3 Detailed schedule and description of preventive maintenance and lubrication tasks organized by the following categories: Daily, Weekly, Monthly, Semi-annually and Annually and including the tools required
 - .4 Descriptive text that provides instruction on actions to be taken in event of equipment failure
 - .5 Recommended spare parts
 - .6 For each piece of equipment, provide a list of resources to call upon for maintenance and servicing of equipment (including supplier's name, address and phone number as well as the service contact)
 - .7 Spare Parts Delivery Transmittal as required by this Section
- .3 Software Manuals
 - .1 Provide EMCS Software User manual including:
 - .1 How to navigate the user interface
 - .2 Contents of menus and feature functions
 - .3 Default "hot" keys for commonly used tasks
 - .4 How to generate reports
 - .5 How to modify parameters or programming instructions for the User Control Language listing all procedures, functions, operators and reserved words together with a description and examples of their use in programming.
 - .6 Instructions for proprietary software used for terminal emulation, communication, graphics generation, etc.
- .4 Computers, Peripheral and Device Manuals
 - .1 Provide instruction and maintenance manuals for all CCSs, PCSs, printers and modems as well as any other peripheral or electronic device supplied under this contract.
- .5 Programmer Control Panel Documentation
 - .1 Provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.
- .6 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 co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
 - .7 System Demonstration and Training
 - .1 EMCS System Demonstration and Training Report for control systems
- .4 Section 4 - EMCS Software (Database/Programming)
 - .1 Sequences of Operation
 - .1 Provide written sequence of operations for all automatically controlled equipment and systems that includes the final parameter set-points determined by the Contractor during system start-up, testing, and commissioning including:
 - .1 Final static pressure set-points
 - .2 Final alarm set-points
 - .3 Programmed occupancy and reset schedules
 - .2 Graphics Interface
 - .1 Provide a hardcopy of all dynamic graphic display screens (if a graphical user interface has been provided).
 - .2 High resolution screen captures may be used for this purpose.
 - .3 Point Lists
 - .1 Provide two complete lists containing all the physical and virtual points in the facility as well as a suitable description as to each points function.
 - .2 The first listing to be sorted by logical point mnemonic, the second to be sorted by hardware address.
 - .3 Each listing to have the following columns:
 - .1 Logical point mnemonic
 - .2 Description
 - .3 Hardware or virtual point address
 - .4 Procedures
 - .1 Provide a brief description of overall control philosophy.
 - .2 Describe all hardware interlocks with other equipment that may affect or override action of software control modules.
 - .3 Provide procedures for operating staff to interface with software control modules, to override system or component operation, to adjust system or building control set-points, etc.

- .4 Name virtual points provided in software for this purpose and recommend adjustment increments and limits where applicable.
- .5 Complete step-by-step procedures for operation of system including required actions at each OWS.
- .6 Operation of computer peripherals, input and output formats.
- .7 Emergency, alarm, and failure recovery.
- .8 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.
- .5 CCS Setup
 - .1 Provide hardcopy listings of all configuration information including CMOS setup, directory listing showing all installed files and locations as well as user interface program configuration data.
 - .2 All listings to be laser printed.
- .5 Section 5 – EMCS Hardware (Configuration/Installation):
 - .1 Organize the information into sub- sections, with index and divider tabs, as follows:
 - .1 EMCS Configuration (include explanations of architecture)
 - .2 TCU Cross References
 - .3 System Schematics
 - .4 RCUs/TCUs
 - .2 EMCS Configuration: Provide a basic configuration diagram showing each CCS, peripheral devices and RCU with information as to their locations. Provide lists or diagrams showing which TCUs are connected to what RCU. Provide an explanation of system architecture. Describe each hardware component and the networks that manage system communications.
 - .3 TCU Cross References: Provide two cross referenced TCU listings. One listing to be sorted by TCU identifier, the other to be sorted by room number. Each listing to have the following columns:
 - .1 TCU identifier
 - .2 RCU sub-network if this data is not in TCU identifier
 - .3 TCU type and model number
 - .4 Terminal equipment identifier (box number etc.)
 - .5 Room number
 - .4 System Schematics: Provide schematics of each mechanical system indicating point locations, mnemonics and hardware

- address. Include any wiring details and equipment schematics showing where and how equipment is interfaced to EMCS. Drawings must be clear and of adequate size for easy reading. If necessary, fold larger sheets into binder.
- .5 RCU/TCUs: Provide a divider tab for each RCU. Under each RCU provide the following information separated with colored sheets:
- .1 RCU panel directory showing point mnemonics, termination addresses and wiring numbers.
 - .2 Panel directory of each associated equipment cabinet.
 - .3 Panel directories of each associated TCU showing point mnemonics, termination addresses and wiring numbers.
- .6 TCU General
- .1 Provide a divider tab for each type of TCU and include the following information separated with coloured sheets:
 - .1 A short general description of the TCU and intended application followed by a listing and description of every available parameter, input and output.
 - .2 A detailed description of each configurable module, object, function, procedure and related sequence of operation.
 - .3 For LonWorks based TCUs, provide functional profile diagrams and descriptions of all Mandatory and Optional Network Variables.
- .7 RCU/TCUs
- .1 Provide a divider tab for each RCU.
 - .2 Under each RCU provide the following information separated with colored sheets:
 - .1 List of physical and virtual point mnemonics with a description of the meaning of each mnemonic.
 - .3 For each User Control Language Program module in the RCU provide:
 - .1 A description of purpose and logic of module
 - .2 A hardcopy listing of the program module
 - .3 Complete hardcopy listing of the RCU database. Include each hardware point, virtual point, schedule, report, trend, controller etc.
 - .4 Provide a divider sub-tab for each associated TCU and include the following information separated with colored sheets:
 - .1 References to any common configurable modules described under the TCU General

- section and a listing of the configuration data for the respective TCU.
 - .2 List of any physical and virtual point mnemonics, with a description of the meaning of each mnemonic.
 - .5 For any User Control Language Program in the TCU provide:
 - .1 A description of purpose and logic of module.
 - .2 A hardcopy listing of the program module.
 - .6 Complete hardcopy listing of the database including each hardware point, virtual point, schedule, report, trend, controller etc.
 - .3 Submittal Procedure
 - .1 Submit EMCS Operation and Maintenance Manuals three times throughout the duration of the project as follows.
 - .1 Submittal #1: Format Review
 - .2 Submittal #2: Pre-TAB Review
 - .3 Submittal #3: Final Submission Review
 - .2 Include all content from previous review submittals, including required revisions in subsequent review submittals.
 - .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.13 FINAL UPDATES, BACKUPS, AND O&M DISKS

- .1 Within 30 days after Substantial Performance of the Work, provide the latest versions of all software and firmware in all CCSs, PCSs, RCUs, and TCUs.
- .2 Within 30 days after Substantial Performance of the Work, provide updated backup packages.
- .3 Within 30 days after Substantial Performance of the Work, provide updated O&M Disks. Copy these updates to all CCS and PCS hard drives.
- .4 Proof of ownership: Provide proof-of-ownership in the form of licensed disks, software manuals, registration cards, or, in the case of proprietary software, formal letter of transmittal, for all software that is required to fulfill contract requirements.
- .5 EMCS Catalogue: Provide a current catalogue and price list that includes the components provided under this contract as well as related system components and accessories.
- .6 Backups: Download all RCU and TCU databases and programs onto the primary CCS hard disk prior to performing a comprehensive backup. Provide three (3) complete system backup packages. Each package shall contain everything necessary to restore the EMCS to full operation should a catastrophic failure occur and as follows:

- .1 Include an image backup of the complete CCS hard disk, onto removable media, using the system backup software specified in Section 15912 “EMCS Central Control Units and Peripherals”.
- .2 Include a copy of the software required to restore the hard drive from the image backup.
- .3 Include text files of the CCS’s CMOS settings as well as any important configuration files such as config.sys and autoexec.bat.
- .4 Include a hardcopy sheet describing the exact steps required to restore the hard drive.
- .5 Include a hardcopy sheet describing the exact steps required to restore an RCU or TCU.
- .7 One backup package shall be left at the primary CCS location. Another is to be included in the Operation & Maintenance Manual that will remain on site. The final package shall be turned over to the Owner through the Departmental Representative.

1.14 EMCS CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Provide EMCS Contractor marked-up As-Built Documents for all EMCS Drawings included in the Contract Documents and drawings prepared by the EMCS Contractor during Shop Drawing Submission.
 - .1 Submit a copy of each drawing in the Contractor As-Built Document Submittal even if that drawing does not contain Contractor mark-ups.
 - .2 EMCS Contractor As-Built Documents shall be submitted separately from the Contractor As-Built Documents required by Section 20 00 01 – Common Work Results – Mechanical.
 - .3 Accessibility
 - .1 EMCS Contractor Marked-up As-Built Drawings shall be available to the Departmental Representative for review at all times throughout Construction.
 - .4 Format during Construction
 - .1 EMCS Contractor Marked Up As-Built Drawings may be maintained in either hard-copy or digital format during construction but must be submitted digitally in accordance with the Submittal Format requirements below.
 - .5 Accuracy
 - .1 Maintain a complete set of EMCS Contractor As-Built Documents from the beginning of the Work through to completion updating them daily as a minimum.
 - .2 Store EMCS Contractor As-Built Documents separate from other documents being used for construction.
 - .3 Incorporate all changes and variances to the EMCS Contract Documents including:
 - .1 Contractor initiated changes due to site coordination
 - .2 Addenda

- .3 Change Orders
- .4 Site Instructions
- .5 Instructions though Requests for Information
- .6 Shop Drawing comments
- .7 Product substitutions or alternates that deviate from the equipment schedules
- .8 Sample and Mock-up comments
- .9 Existing systems that are affected by demolition or renovation work
- .10 Changes made as required by Manufacturer's installation instructions
- .11 Changes made as part of Testing, Adjusting, and Balancing
- .12 Changes made as part of System Start-up
- .13 Changes made as part of System Commissioning
- .6 Specific Information Required
 - .1 Ensure the following specific information is clearly indicated on the EMCS Contractor As-Built Drawings:
 - .1 All information relating to concealed conditions
 - .2 Field changes of dimension and detail
 - .3 Pertinent installation details not shown in the Contract Document Drawings
 - .4 Updated Contractor Drawing equipment schedules showing installed product details and parameters (manufacturer, model, performance parameters, capacity, etc.) data differs from the base specification shown on the Drawings
 - .5 Other specific As-Built requirements throughout Division 25
 - .6 Location of:
 - .1 All tagged equipment
 - .2 Panels
 - .3 Transformers
 - .4 Switches
 - .5 Thermostats
 - .6 Sensors
 - .7 Low voltage control wiring
 - .8 Operators Work Station
 - .9 Control valves
 - .10 Visual/audio alarms
 - .7 Routing of:
 - .1 Main communication trunks
 - .2 Control air lines
- .2 Submittal Format

- .1 Contractor As-Built Documents shall be submitted in PDF format.
- .2 Note entries in red text and deletions in blue.
- .3 Ensure entries are clear and legible, complete, and accurate.
 - .1 EMCS Contractor As-Built Drawings shall not contain notes or other markings that are not indicative of as-built conditions.
- .4 The Contractor shall mark each As-Built Drawing with a stamp in the bottom right hand corner, or in the title block, that reads, "EMCS AS-BUILT DRAWINGS AS RECORDED BY THE CONTRACTOR" (Signature of Contractor) (date) or equivalent text that indicates that the Contractor has incorporated all required information into the drawing set
- .3 Submittal Procedure
 - .1 Upon request by the Contractor, the Departmental Representative will provide a full set of the Contract Document Drawings in .PDF format for the Contractor's use in preparing the marked-up EMCS As-Built Drawings
 - .2 After the Work has been completed and after the deficiencies have been corrected and signed-off as complete, the EMCS Contractor shall sign and date each EMCS As-Built Drawing (including those where no changes have occurred)
 - .3 Scan the entire set of marked-up EMCS As-Built Drawings in .PDF format and submit to the Departmental Representative to review that the required information has been incorporated and they are compliant with the requirements of this Section
 - .1 Marked-up EMCS As-Built Drawings that are submitted in an alternate format, are missing required information, are incomplete, or that do not bear the Contractor's signature and date are subject to be rejected and declared incomplete.
 - .2 Incorporate comments made by the Departmental Representative and resubmit for additional review as requested
 - .4 Include a copy of the original Contractor marked-up EMCS As-Built Drawings in the Operation and Maintenance Manuals
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Departmental Representative's written acceptance of the documentation.

1.15 SPARE PARTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Provide spare parts for this Section as follows:
 - .1 Room Temperature Sensors (Security Type): Three (3)

1.16 EMCS SYSTEM DEMONSTRATION AND TRAINING REQUIREMENTS

- .1 General Requirements

- .1 Provide EMCS System Demonstration and Training in accordance with Section 20 00 01 – Common Work Results – Mechanical supplemented by the requirements of this Section.
- .2 Timing
 - .1 Coordinate the schedule of EMCS System Demonstration and Training with other System Demonstration and Training requirements provided in Section 20 00 01 - Common Work Results - Mechanical.
- .3 Execution
- .4 Demonstration and Training Topics
 - .1 System Demonstration and Training shall cover (as a minimum):
 - .1 Overview of EMCS components
 - .2 Demonstration of Application Software
 - .1 Man/machine interface to EMCS system, including operator access, all monitoring functions and command of points.
 - .2 Saving and reloading of database. Provide a checklist describing the procedures to be followed.
 - .3 The use of disk backup utilities by creating bootable CDs containing a complete image backup of the hard disk. Save must be performed at the highest rewrite speed available on CD-RW drive. Provide a checklist describing the procedures to be followed.
 - .4 User Control Language program entry and editing.
 - .5 Operation of specific application software such as:
 - .1 Demand limiting
 - .2 Peak shaving
 - .3 Night setback
 - .4 Optimum start of heating/cooling systems
 - .5 Building dynamic control
 - .6 Alarm conditions and printouts
 - .7 Automatic report generation
 - .3 Operation of hardware components
 - .1 Calibration of sensors
 - .2 Troubleshooting of components
 - .3 Preventative maintenance
 - .4 Demonstration of System Integrity
 - .1 Power fail and restart of CCU, RCU, TCU
 - .2 Network failure and restart
 - .3 Sensor failure and recovery in RCU and TCU
 - .4 Fail-safe modes for all valves, dampers and equipment.
 - .5 Fail-safe and emergency modes for systems.
 - .5 Demonstration of Control Sequences

- .1 Control sequences under all modes of electrical power
 - .2 Component hard-wired interlocks
 - .6 Contact Instructions for emergency service calls
 - .7 Demonstration of sensors and monitor functionality
 - .1 Including but not limited to:
 - .1 Space temperature sensors/thermostats
 - .2 Room pressure differential monitors
 - .3 Gas monitors
- .5 EMCS Demonstration and Training Plan
 - .1 Submittal Procedure:
 - .1 Submit one (1) copy to the Departmental Representative for review a minimum of fifteen (15) working prior to desired date of training.
 - .2 Insert one (1) complete copy of the final document in the Operation and Maintenance Manuals in advance of Operation and Maintenance Manuals Review Submittal.
 - .2 Format:
 - .1 Submittal Format: PDF file
 - .2 Organize the Plan as follows:
 - .1 Desired date of training (coordinated by the Contractor with other training activities)
 - .2 Training agenda
 - .3 Sample sign-in sheet
 - .4 List of visual/audio aids that will be used for training
 - .5 Names of training personnel
 - .6 Description of representative Owner staff from facilities who should be present for the training
 - .3 Acceptance Criteria:
 - .1 The EMCS Demonstration and Training Plan shall be considered complete upon written acceptance by the Departmental Representative and Owner.
- .6 EMCS Demonstration and Training Report
 - .1 Submittal Procedure:
 - .1 Submit one (1) copy to the Departmental Representative for review no later than (10) working days after the date of training.
 - .2 Insert one (1) complete copy of the final document in the Operation and Maintenance Manuals in advance of Operation and Maintenance Manuals Review Submittal.
 - .2 Format:
 - .1 Submittal Format: Emailed PDF file complete with index and bookmarks
 - .2 Organize the Report as follows:
 - .1 The date and time the training took place

- .2 Name of training personnel
 - .3 The agenda for the training session updated to include any other important topics discussed
 - .4 A copy of the sign-in sheet indicating each person who was present (including the Owner, Contractor, and Commissioning Lead representatives as applicable)
 - .5 A list of any materials that have (or will be) turned over to the Owner to supplement the training session (videos, literature, etc.)
 - .6 Lessons learned and information gathered on the operations of the systems used to maintain an environment at the worksite during the construction phase
 - .7 Any supplemental information requested to be inserted into the Operation and Maintenance Manuals during the session
 - .8 Information on supplemental training courses that can be provided as a future service (for new staff or refresher courses) including costs and contact information
 - .9 A statement prepared by the Contractor, signed by both the Contractor and Owner, indicating that the training session has been satisfactorily completed
- .3 Acceptance Criteria:
- .1 EMCS Demonstration and Training shall be considered complete upon submission of the statement of completion signed by the Owner.

1.17 SUBSTANTIAL COMPLETION

- .1 Refer to Section 20 00 01 – Common Work Results – Mechanical for substantial completion requirements.

1.18 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 EMCS Integration Report
 - .2 Shop Drawings
 - .1 Shop drawings for all equipment required in Division 25 Sections

1.19 EMCS INTEGRATION REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Inspect the existing control system (performing tests as necessary) and provide a report confirming the work of Division 25 and the equipment being provided by the EMCS Contractor is fully compatible with the

- existing control system architecture without the need for additional work or equipment not defined by the Contract Documents.
- .2 Perform tests as necessary prior to starting work to ensure all control data is being transferred between each device in the network.
- .2 Submittal Format
 - .1 Provide the following information:
 - .1 Components/systems which can be reused:
 - .1 Provide a list of each component capable of being re-used that meets the requirements of the Contract Documents
 - .2 Provide a list of components that meet the requirements of the Contract Documents, but require repairs or are non-functioning (indicating the nature of repairs required).
 - .2 Components/systems incapable of being reused:
 - .1 Provide a list of each component that is not fully compatible with the requirements of Division 25
 - .2 For each non-compliant component, reference the specification clause stating functional requirements that cannot be met
 - .3 For each non-compliant component, provide the EMCS Contractors recommended solution or equipment required to meet the requirements of the Contract Documents.
- .3 Submittal Procedure
 - .1 Complete the work and submit the report within 40 days of award of contract and prior to new construction work.
 - .2 Failure to submit the report will constitute acceptance and compatibility of existing devices by the Contractor
 - .3 Coordinate the inspection work with the Owner and receive written permission before disconnecting or testing any control components

1.20 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Information Documents
 - .1 EMCS System Demonstration and Training Plan
 - .2 EMCS System Demonstration and Training Report
 - .2 EMCS Operation and Maintenance Manuals Content
 - .1 EMCS Operation and Maintenance Manuals requirements where specified in Division 25 Sections
 - .3 EMCS Contractor As-Built Markups Content
 - .1 EMCS Contractor As-Built Markup requirements where specified in Division 25 Sections
 - .4 Spare Parts

- .1 Spare parts requirements where specified in Division 25 Sections

1.21 EMCS SYSTEM DEMONSTRATION AND TRAINING PLAN

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results – Mechanical and this Section.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a written plan describing the details of the EMCS System Demonstration and Training execution.
 - .2 Submittal Format
 - .1 Organize the System Demonstration and Training Plan as follows:
 - .1 Desired date of training (coordinated by the Contractor with other training activities)
 - .2 Training agenda
 - .3 Sample sign-in sheet
 - .4 List of visual/audio aids that will be used for training
 - .5 Names of training personnel
 - .6 Description of representative Owner staff from facilities who should be present for the training
 - .3 Submittal Procedure
 - .1 Submit one (1) copy to the Departmental Representative for review a minimum of fifteen (15) working days prior to the first planned training session date.
 - .2 Schedule EMCS System Demonstration and Training during regular work hours or at alternate times approved by the Owner
 - .3 Make any revisions to the EMCS System Demonstration and Training Plan as required by the Departmental Representative or the Owner for resubmission prior to performing system demonstration and training.

1.22 EMCS SYSTEM DEMONSTRATION AND TRAINING REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results – Mechanical and this Section.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a report showing that EMCS System Demonstration and Training has been completed satisfactorily to the Owner.
 - .2 Submittal Format
 - .1 Organize the System Demonstration and Training Plan as follows:

- .1 The format and training agenda shall be in accordance with the HVAC Commissioning Process, ASHRAE Guideline 1-1989R, 1996 are an equivalent standard
 - .2 The date and time the training took place
 - .3 Name of training personnel
 - .4 The agenda for the training session updated to include any other important topics discussed
 - .5 A copy of the sign-in sheet indicating each person who was present (including the Owner, Contractor, and Commissioning Lead representatives as applicable)
 - .6 A list of any materials that have (or will be) turned over to the Owner to supplement the training session (videos, literature, etc.)
 - .7 Lessons learned and information gathered on the operations of the systems used to maintain an environment at the worksite during the construction phase
 - .8 Any supplemental information requested to be inserted into the Operation and Maintenance Manuals during the session
 - .9 A statement prepared by the Contractor, signed by both the Contractor and Owner, indicating that the training session has been satisfactorily completed
- .3 Submittal Procedure
 - .1 Submit one (1) copy to the Departmental Representative for review no later than ten (10) working days after the date of each training session.
 - .2 Insert one (1) complete copy of the final EMCS System and Demonstration and Training Report in the EMCS Operation and Maintenance Manuals.
- .3 Acceptance Criteria:
 - .1 EMCS System Demonstration and Training shall be considered complete upon submission of the signed statement of completion signed by the Owner for each of the training sessions indicated in the EMCS System Demonstration and Training Plan.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS/CONTRACTORS

- .1 ESC Automation
- .2 JCI
- .3 Siemens

2.2 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 bid documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.3 ADAPTORS

- .1 Provide adaptors between metric and imperial components.

Part 3 Execution

3.1 EQUIPMENT ACCESS

- .1 Access for Maintenance
 - .1 Coordinate the timing of the work with other trades to ensure that the minimum required maintenance space (for servicing, lubrication, disassembly, and removal of equipment or components) is maintained.
 - .1 The Contractor shall be responsible for remedial work required where the work of one Sub-Contractor infringes on the required access space for equipment due to inadequate coordination or planning
 - .2 The required access area for maintenance shall be the greater value between the minimum dimensions recommended by the manufacturer, dimensions indicated on the drawings, or dimensions required by the specifications.
 - .1 Regardless of published minimum requirements for maintenance access, coordinate and install the systems so that equipment can be maintained in a safe manner.
 - .2 The Departmental Representative (along with the Owner's representative) reserves the right to determine if equipment can be maintained in a safe manner.
- .2 Access Doors
 - .1 Supply and install access doors for all concealed mechanical equipment requiring maintenance (supplemented by locations shown on the plan drawings) to suit site conditions to enable access for operating, inspecting, adjusting, and servicing.
 - .2 Access doors are not required in lay-in tile ceilings. Provide Above-Ceiling Equipment Markers in accordance with Section 20 15 43 – Mechanical Identification.
 - .3 Ensure that equipment requiring maintenance is clearly within view and is easily reachable for operating, inspecting, adjusting, and servicing without the need for special tools or removal of obstructing equipment.

3.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store, and handle materials in accordance with the manufacturer's requirements, and that of Division 01.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with the manufacturer's recommendations in clean, dry, well-ventilated area
 - .2 Store and protect materials from nicks, scratches, and blemishes
 - .3 Replace defective or damaged materials with new

3.3 PAINTING

- .1 Provide painting in accordance with the requirements of Division 09 supplemented as follows.
- .2 Apply a minimum of one coat of corrosion resistant primer paint to all ferrous supports and site fabricated equipment.
- .3 Provide system identification in accordance with the requirements of Section 20 15 43 – Mechanical Identification.
- .4 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
- .5 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
- .6 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

3.4 REPAIRS AND RESTORATION

- .1 Restore finishes that have been damaged throughout the course of construction to new condition.

3.5 CLEANLINESS

- .1 Clean the construction site daily in accordance with the requirements of Division 01.
- .2 Cleanliness During Construction:
 - .1 Clean concealed areas (i.e. above ceiling spaces) as required to maintain dust-free surfaces on equipment and services
 - .2 Refer to Section 23 31 13 – Ductwork for special requirements for duct cleanliness
- .3 Final Cleaning:
 - .1 Clean the exterior surfaces of all equipment
 - .2 Clean the interior surfaces of all equipment with maintenance access doors or panels
 - .3 Replace all filters with new media
 - .4 Clean all strainers in piped systems

3.6 WASTE MANAGEMENT

- .1 Remove, store, or reuse construction waste in accordance with the requirements of Division 01.

3.7 ELECTRICAL WORK

- .1 Provide electrical work in accordance with the requirements of Division 26 supplemented by the requirements of each Section.
- .2 All control wiring to conform to the requirements of Division 26 including conduit, wiring and connections below 50 V that are related to control systems specified in Division 25 and/or shown on mechanical drawings.

- .3 Refer to Division 26 for the quality of materials and workmanship requirements.

3.8 FIELD QUALITY CONTROL

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative 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.
 - .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 Check equipment cooling fans as required.
 - .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
 - .4 Review system performance with Departmental Representative 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.

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- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
- .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.1, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations
- .2 Alberta Infrastructure
 - .1 Technical Design Requirements for Alberta Infrastructure Facilities – Second Edition May 2016.

1.2 SYSTEM DESCRIPTION

- .1 Language Operating Requirements: provide identification for control items in English.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 EMCS Systems and Equipment Identification Directory

1.4 EMCS SYSTEMS AND EQUIPMENT IDENTIFICATION DIRECTORY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 25 05 01 – EMCS General Requirements and Section 20 00 01 - Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a directory showing the nomenclature used for all EMCS system and service identification.
 - .2 Submittal Format
 - .1 List of all tagged equipment (on both the drawings and specifications) with the following:
 - .1 Short description of equipment function
 - .2 Equipment tag number that will appear on the nameplates
 - .3 Description of the equipment location
 - .2 List of all piping and ductwork system with the following:
 - .1 Short description of system function
 - .2 The following identification information for each system:
 - .1 The label identification nomenclature
 - .2 The symbols that will be used (flow arrow, etc.)
 - .3 Actual dimensions of text and arrows

- .4 Identification colors/banding etc.
- .3 Provide a reduced scale, color drawing showing a typical example sample of:
 - .1 An equipment nameplate
 - .2 The actual identification of a distribution system as it will appear as applied on site
 - .3 Sample of above-ceiling equipment markers that will be used

1.5 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 EMCS Operation and Maintenance Manuals Content
 - .2 EMCS Contractor As-Built Markups Content

1.6 EMCS OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the EMCS Operation and Maintenance Manuals in accordance with Section 25 05 01 – EMCS General Requirements.

1.7 EMCS CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 25 05 01 – EMCS General Requirements.

Part 2 Products

2.1 ENGRAVED PLASTIC NAMEPLATES

- .1 Self-adhesive composite laminated plastic nameplates with one smooth white surface and core of black plastic designed to leave black lettering on a white background
- .2 Engraved lettering height as follow:
 - .1 RCU, TCU, and Equipment Cabinets: 20mm
 - .2 Magnetic contactors for EMCS controlled equipment: 20mm
 - .3 All other: 8mm.

2.2 POINT IDENTIFICATION TAGS

- .1 0.75mm thick plastic laminated luggage style tags containing imprinted information label.
- .2 Printing on surface of plastic is not permitted.
- .3 Printing shall be 14-point font or larger.

2.3 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".

2.4 EMCS CABINET DIRECTORIES

- .1 For each equipment cabinet provide a laminated sheet graphically showing the location of each transducer, relay or other device in the cabinet.
- .2 Each device outline to be labelled and function of device indicated.
- .3 Provide logical point mnemonic, descriptor, wiring label and hardware address for field wiring terminating at transducers and relays within the cabinet.

2.5 EMCS WIRING DIRECTORIES

- .1 For each RCU and TCU provide a laminated sheet with a cross-referencing listing of logical point mnemonic, descriptor, wiring label and hardware address for each wire terminated in cabinet.
- .2 Order and placing of information shall mimic pattern of wiring terminations.

2.6 WIRING

- .1 Use one the following:
 - .1 Heat shrink sleeves with thermally printed identifier.
 - .1 Label material and printing to be resistant to oil, mineral solvent and methyl alcohol.
 - .2 Snap-on or slide-on sleeves, crimp-on pins with integral sleeve.
 - .1 Length to suit number of characters required in identification cod, (6 (six) characters minimum.
 - .2 Marking elements to be removable yet secure when inserted into sleeve.
 - .3 Factory coded slip-on identification bead markers or sleeves.
- .2 Size of sleeves to be selected so that they do not slip off when wire is removed from termination and shaken.
- .3 Wrap-on adhesive strips and hand-written identifiers are not allowed.
- .4 Colour Coding
 - .1 To CSA C22.
 - .2 Use colour coded wiring in communications cables, matched throughout system.
- .5 Power Wiring
 - .1 Identify circuit breaker panel/circuit breaker number inside each EMCS panel.

Part 3 Execution

3.1 CONDUIT

- .1 Apply paint or colour banding tape in fluorescent orange for control wiring conduit in 35mm wide bands all around conduit as follows:
 - .1 At least once in each 10m of conduit run.
 - .2 Where conduit enters in accessible ceilings, wall and floor spaces.
 - .3 At least once in each room or area through which a conduit passes.
- .2 Apply fluorescent orange paint to all conduit fittings prior to installation is an acceptable practice, however, additional identification banding shall be added as required to meet all of the requirements of this section.
- .3 Pre-paint box covers.

3.2 WIRING

- .1 Wiring more than 1m in length must be labelled at both ends including at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Labels for all systems point wiring shall, as a minimum contain the following information:
 - .1 Panel end: panel terminal number or hardware address.
 - .2 Device end: panel number as well as panel terminal number or hardware address.
- .3 Label panel power supply wiring with the panel connector number.
- .4 Label communications port wiring with panel connector number and device name (e.g. "J1-modem", "J2-printer").
- .5 Label communications trunk wiring with panel connector number, router number, etc. to which the other end of the cable is connected.
- .6 Wiring on each side of a terminal block or splice shall be labeled with the information required for the device end of the wire.
- .7 In retrofit situations the above labeling requirements are in addition to any existing labeling.

3.1 POINT TAGGING

- .1 Identify all input sensors and devices as well as all EMCS controlled output actuators, motors, and equipment with Point Identification Tags. Provide multiple tags as necessary.
- .2 Additional requirements as follows:
 - .1 Tag control wiring for major mechanical equipment at equipment terminal strip.
 - .2 Tag and input/output transducers not identified on an Equipment Cabinet Directory.
 - .3 Tag electric motors on power cable near motor end.
- .3 Point Identification Tags shall be attached using nylon cable ties. One tie is to provide loose loop through the tag while the other tie is to hold this loop to the wire or conduit.

- .4 All Point Identification Tags shall include the following minimum information:
 - .1 Logical Point Mnemonic.
 - .2 Point Hardware Address (RCU/TCU and connection terminal identifiers).
 - .3 Associated System Identification.
 - .4 Point Description

3.2 NAMEPLATES

- .1 Identify the following with engraved plastic nameplates.
 - .1 Magnetic contactors and related local disconnect switches.
 - .2 Space temperature sensors and intelligent thermostats.
 - .3 RCU cabinets, TCU cabinets, associated equipment cabinets.
 - .4 Front panel mounted switches, displays and devices; identify function of each item.
- .2 Nameplates shall include logical point mnemonic as applicable.
- .3 All nameplates to be easily visible without the need to use ladder or extraordinary body position.
 - .1 Affix additional nameplates if necessary.

3.3 DIRECTORIES

- .1 Permanently mount laminated Wiring Directories on door inside surface of each RCU and TCU cabinet.
- .2 Permanently mount laminated Equipment Cabinet Directories on door inside surface of each equipment cabinet.

3.4 EXISTING PANELS

- .1 Replace existing nameplates and legends to the standard of this Section and 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, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings
 - .2 ANSI C2, National Electrical Safety Code
 - .3 ANSI/NFPA 70, National Electrical Code
- .2 Canadian Standards Association (CSA)
 - .1 CSA C22.1
 - .2 CAN/CSA-C22.3 No. 7, Underground Systems
 - .3 CSA C22.2 No. 45.1, Electrical Rigid Metal Conduit
 - .4 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
 - .5 CSA C22.2 No. 83], Electrical Metallic Tubing
 - .6 CAN/CSA-C22.3 No. 1, Overhead Systems

1.2 SYSTEM DESCRIPTION

- .1 Electrical:
 - .1 Provide all line and low voltage power wiring from normal power panels, emergency power panels and UPS to EMCS field panels and control devices requiring power. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches. The EMCS contractor shall bear all cost for line voltage wiring, conduit, and devices needed to power field panels and devices required for EMCS. EMCS contractor shall hire, reimburse and coordinate line voltage requirements with successful Division 26 contractor.
 - .2 Provide power to all trap primer valves and infrared/hands free sinks. Refer to drawings and specifications for location and requirements.
 - .3 Hard wiring between field control devices and EMCS field panels.
 - .4 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
 - .5 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .6 Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by engineer before commencing work.
- .2 Mechanical:
 - .1 Pipe Taps Required For EMCS equipment will be supplied and installed by Division 20, 21, 22, or 23 Contractor.

- .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 20, 21, 22 or 23 Contractor.
- .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23 Contractor. Costs to be carried by designated trade. Devices to be supplied by EMCS Contractor.
- .3 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: refer to Division 1 supplemented as specified herein.
- .2 Repair all surfaces damaged during execution of work.
- .3 Turn over to Owner existing materials removed from work not identified for re-use. If the Owner does not want existing materials, dispose in accordance with authority having jurisdiction and Waste Management and Disposal Plan.

1.5 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.6 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results – Mechanical and Section 25 05 01 – EMCS General Requirements.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 EMCS Operation and Maintenance Manuals Content
 - .2 EMCS Contractor As-Built Markups Content

1.8 EMCS OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the EMCS Operation and Maintenance Manuals in accordance with Section 25 05 01 – EMCS General Requirements.

1.9 EMCS CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 25 05 01 – EMCS General Requirements.

Part 2 Products

2.1 SPECIAL SUPPORTS

- .1 Structural grade steel, primed and painted after construction and before installation.

2.2 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: #18AWG stranded twisted pair.
 - .4 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair. 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.

2.3 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.

2.4 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.

2.5 STARTERS, CONTROL DEVICES

- .1 Starters and VFD's:
 - .1 Refer to Division 26. Starters and VFD's by Division 26.

2.6 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 SUPPORTS

- .1 Install special supports as required and as indicated.

3.3 ELECTRICAL GENERAL

- .1 Do complete installation in accordance with requirements of:
 - .1 Division 26 and 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 C22.3No.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.

3.4 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 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 26.
- .17 Install bonding conductor for 120 volt and above in conduit.

3.5 WIRING

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:
 - .1 Circuits are continuous, free from shorts, unspecified grounds.
 - .2 Resistance to ground of all circuits is greater than 50 Megohms.
- .5 Provide Consultant with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 IDENTIFICATION

- .1 Refer to Section 25 05 54 - EMCS Identification.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Canada Labour Code (CLC)
 - .1 Part I - Industrial Relations

1.2 GENERAL WARRANTY REQUIREMENTS

- .1 Provide warranty for all work and materials of Division 25 in accordance with the requirements of Division 0 and Section 20 00 01 – Common Work Results - Mechanical.

1.3 REGULAR SERVICE WORK DURING WARRANTY PERIOD

- .1 EMCS Contractor shall provide full service support throughout the warranty period at no additional cost to the Owner, providing replacement parts, adding/modifying BMS code, troubleshooting operational issues, etc. to meet and maintain the control functionality specified in the Contract Documents.
- .2 Service personnel shall be knowledgeable about the building's specific control systems, be qualified to perform the work, and have access to replacement parts available locally to facilitate maintenance work.
- .3 Submit EMCS Contractor Service Information Summary in accordance with the requirements of this Section.
- .4 Submit a Record of EMCS Service Work in accordance with the requirements of this Section each time service work is performed.

1.4 EMERGENCY SERVICE WORK DURING WARRANTY PERIOD

- .1 EMCS Contractor shall have the ability to provide emergency service support during the warranty period by providing the following:
 - .1 Ability to respond to and perform emergency service work no more than 2 hours after receiving an emergency service call request
 - .2 Provide qualified service personnel that fully understand the specific control systems of the facility and be capable of providing detailed instruction on how to operate or modify the control systems, how to perform routine maintenance, or how to perform emergency service on the system.
 - .3 Ability to work continuously until EMCS has been restored to a safe and reliable state
- .2 Submit EMCS Contractor Service Information Summary in accordance with the requirements of this Section.
- .3 Submit a Record of EMCS Service Work in accordance with the requirements of this Section each time service work is performed.

1.5 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:

- .1 Information Documents
 - .1 EMCS Contractor Service Information Summary
- .2 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.6 EMCS CONTRACTOR SERVICE INFORMATION SUMMARY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Demonstrate the ability to provide normal and emergency maintenance service during the warranty period in accordance with the requirements of this Section.
 - .2 Submittal Format
 - .1 Include the following information:
 - .1 Name of local service company or department
 - .2 Identify personnel by name who are knowledgeable about the specific Work and systems installed as part of this project
 - .3 Contact phone numbers and emails for regular warranty service work
 - .4 CV information for the listed service personnel
 - .5 Statement of assurance that emergency service work can performed in accordance with the requirements of this Section
 - .6 Contact phone numbers and emails for emergency warranty service work
 - .3 Submittal Procedure
 - .1 Submit at the time of shop drawing submission.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Certification Reports
 - .1 EMCS Contractor's Certificate of Warranty
 - .2 Information Documents
 - .1 Record of EMCS Service Work
 - .3 Operation and Maintenance Manuals Content
 - .4 Contractor As-Built Markups Content
 - .5 Spare Parts

1.8 EMCS CONTRACTOR'S CERTIFICATE OF WARRANTY

- .1 General Requirements

- .1 Submit in accordance with the requirements of Division 0 supplemented by the requirements of this Section.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a signed statement indicating full warranty for the Work and equipment provided by the EMCS Contractor and the EMCS Sub-Contractors in accordance with the warranty requirements specified in Division 0 or a required by the specifications of Division 25.
 - .2 Submittal Format
 - .1 Include the following:
 - .1 Approved date of Substantial Performance
 - .2 Description of all work and equipment covered by the warranty
 - .3 Warranty end date
 - .4 Name of the Contractor Company carrying the warranty
 - .5 Name and signature of the Contractor's employee having authority to warranty the work
 - .6 Where Extended Warranties are required, provide a clear description of the applicable systems or equipment the Extended Warranty applies to
 - .3 Submittal Procedure
 - .1 Include a copy of all Declaration of Warranties in the Operation and Maintenance Manual

1.9 RECORD OF EMCS SERVICE WORK

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a record of service work for each service call request made during the warranty period.
 - .2 Submittal Format
 - .1 Each time service work is performed, record the following:
 - .1 Date and time service call request was made by the Owner
 - .2 Date and time service call was first responded to by the service company
 - .3 Name of Service Company and personnel assigned to the service call
 - .4 Description of the control system behavior prompting a service call request
 - .5 Description of the specific equipment or components requiring maintenance

- .6 Description of the work required to be performed to resolve the service request
- .7 Indicate if the work was considered emergency work
- .8 Summary of material and time spent required to resolve the service request
- .9 Time and date of service call completion
- .3 Submittal Procedure
 - .1 Consolidate all Records of EMCS Service Work one month before the end of the warranty period and provide to the Owner for inclusion in the EMCS Operations and Maintenance Manual

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 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C12.7, Requirements for Watt-hour Meter Sockets
 - .2 ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B148, Standard Specification for Aluminum-Bronze Sand Castings
- .3 National Electrical Manufacturer's Association (NEMA)
 - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- .4 Air Movement and Control Association, Inc. (AMCA)
 - .1 AMCA Standard 500-D, Laboratory Method of Testing Dampers for Rating
- .5 Canadian Standards Association (CSA)
 - .1 CSA-C22.1, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations

1.2 DEFINITIONS

- .1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS General Requirements.

1.3 EXISTING CONDITIONS

- .1 Cutting and Patching: in accordance with Division 1 supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.
- .3 Turn over to Owner existing materials removed from Work not identified for re-use. If Owner does not want existing materials, dispose in accordance with authorities having jurisdiction and Waste Management requirements.

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.5 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results – Mechanical and Section 25 05 01 – EMCS General Requirements.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 EMCS Operation and Maintenance Manuals Content
 - .2 EMCS Contractor As-Built Markups Content

1.7 EMCS OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the EMCS Operation and Maintenance Manuals in accordance with Section 25 05 01 – EMCS General Requirements.

1.8 EMCS CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 25 05 01 – EMCS General Requirements.
- .2 Specific Requirements
 - .1 In addition to the general requirements for EMCS Contractor As-Built Documents Markups indicated in Section 25 05 01 – EMCS General Requirements, indicate the following:
 - .1 Location of:
 - .1 Sensors
 - .2 Transmitters
 - .3 Switches
 - .4 Valves
 - .5 Gauges
 - .6 Dampers
 - .7 Panels
 - .8 Transformers
 - .9 Airflow Stations

1.9 EMCS SYSTEM DEMONSTRATION AND TRAINING

- .1 General Requirements
 - .1 Provide system demonstration and training for the work of this Section in accordance with the requirements of Section 25 05 01 – EMCS General Requirements and Section 20 00 01 - Common Work Results – Mechanical.

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, vibration-proof, 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 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .8 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.
- .9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 – EMCS 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.
 - .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 or 150 mm as required.
- .2 Room temperature/occupancy 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 or contractor supplied palm compatible handheld device for access to zone bus.
 - .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.

- .8 Integral occupancy sensor.
- .2 Room temperature sensors.
 - .1 Wall mounting, in slotted type covers having brushed aluminum or brushed stainless steel finish, with guard as indicated.
 - .2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
 - .3 Integral occupancy sensor.
- .3 Duct temperature sensors:
 - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm or as indicated.
 - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.
- .4 Outdoor air temperature sensors:
 - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

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 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 500 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 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.

2.5 PRESSURE TRANSMITTERS

.1 Requirements:

- .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
- .2 Output signal: 4 - 20 mA into 500 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.

2.6 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.

2.7 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 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.8 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 duct velocity.

2.9 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.

2.10 TEMPERATURE SWITCHES

- .1 Requirements:
 - .1 Operate automatically. Reset automatically, except as follows:
 - .1 Low temperature detection: manual reset.
 - .2 High temperature detection: manual reset.
 - .2 Adjustable setpoint and differential.
 - .3 Accuracy: plus or minus 1 degrees C.
 - .4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
 - .5 Type as follows:
 - .1 Room: for wall mounting on standard electrical box with without protective guard as indicated.
 - .2 Duct, general purpose: insertion length = 460 mm.

- .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
- .4 Low temperature detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
- .5 Strap-on: with helical screw stainless steel clamp.

2.11 ELECTROMECHANICAL RELAYS

- .1 Requirements:
 - .1 Double voltage, DPDT, plug-in type with termination base.
 - .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
 - .3 Contacts: rated at 5 amps at 120 V AC.
 - .4 Relay to have visual status indication

2.12 STATE RELAYS

- .1 General:
 - .1 Relays to be socket or rail mounted.
 - .2 Relays to have LED Indicator
 - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
 - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
 - .5 Relays to be CSA Certified.
 - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
 - .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
 - .1 Control voltage, 3 to 32 VDC.
 - .2 Drop out voltage, 1.2 VDC.
 - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output.
 - .1 AC or DC Output Model to suit application.

2.13 CURRENT TRANSDUCERS

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-1 volt DC.
 - .3 0-10 volts DC.
 - .4 0-20 volts DC.
- .3 Frequency insensitive from 10 - 80 hz.

- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.14 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Split core for easy mounting.
 - .4 Induced sensor power.
 - .5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
 - .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
 - .7 Adjustable latch level.

2.15 CONTROL DAMPERS

- .1 Construction/Type: Refer to Section 23 33 15.
- .2 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
 - .1 Refer to Section 23 33 15.
 - .2 25 L/s/m² maximum allowable leakage against 1000 Pa static pressure for outdoor air and exhaust air applications.
 - .3 Temperature range: minus 40 degrees C to plus 100 degrees C.
- .3 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.
- .4 Jack shafts:
 - .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
 - .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
 - .3 Install using manufacturers installation guidelines.
 - .4 Use same manufacturer as damper sections.

2.16 ELECTRONIC CONTROL DAMPER ACTUATORS

- .1 Requirements:
 - .1 Direct mount proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
 - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

- .4 Power requirements: [5]VA maximum at 24 V AC.
- .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
- .6 For VAV box applications floating control type actuators may be used.
- .7 Damper actuator to drive damper from full open to full closed in less than [120]seconds.

2.17 PANELS

- .1 Free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required indicated to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.
- .3 Panels to be lockable with same key.

2.18 AIRFLOW MEASURING STATIONS

- .1 Provide airflow stations to continuously measure the fan or duct air volumes.
- .2 Each airflow station shall consist of multiple total and static pressure probes positioned as specified by the National Environmental Balancing Bureau (NEBB) for proper duct traverses. Each probe shall have a continuous slot along the entire length of the probe to ensure an accurate average velocity pressure (accuracy to be within 5 percent). The airflow station frame shall be constructed of galvanized steel, 150 mm depth, with 25 mm mounting flanges. The probes shall be constructed of aluminum tubing and connected together internally with plastic tubing (FR rated).
- .3 An identification label shall be installed on each station showing station number, location, size and velocity pressure, l/s conversion.
- .4 Confirm location of flow station on site with manufacturer.
- .5 Velocity pressure transmitter and transducer shall be provided by controls contractor.
- .6 The airflow station shall be the Hydro-Air Flow Station as manufactured by Hydro-Air Engineering Services. No exceptions.

2.19 ROOM USER INTERFACE PANEL

- .1 Provide and install a graphical user interface panel that will display and allow user adjustment of room temperature and relative humidity where temperature and humidity sensors are located remote from room.
- .2 Unit shall employ BACnet network capabilities for interface with EMCS.
- .3 Acceptable Material: LOYTEC L-Vis panel.

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, humidity transmitters, solenoid air valves, 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 pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.
- .6 Electrical:
 - .1 Complete installation in accordance with Section 26 05 01 - Common Work Results Electrical.
 - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .3 Refer to 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 Departmental Representative 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. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.

- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
 - .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
 - .2 Wire multiple sensors in series for low temperature protection applications.
 - .3 Wire multiple sensors separately for temperature measurement.
 - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells: install for piping installations.
 - .1 Locate well in elbow where pipe diameter is less than well insertion length.
 - .2 Thermowell to restrict flow by less than 30%.
 - .3 Use thermal conducting paste inside wells.

3.3 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 40 11- EMCS :Start-up and Testing.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Public Works and Government Services Canada (PSPC) / Real Property Branch (RPB) / Architectural and Engineering Services
 - .1 MD13800, Energy Management and Control Systems (EMCS) Design Manual.
English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.2 REQUIREMENTS

- .1 General Requirements
 - .1 The sequences of operation indicated in this Section describe the general intent of control for the equipment.
 - .1 Stable PID gains shall be determined for each control function and additional programming shall be provided as required to provide fully-functioning and stable operation for all states of operation and seasons.
 - .2 Provide the database for all physical points listed in Section 25 90 02 – EMCS Control Point Schedules.
 - .3 Provide the database for all virtual points identified in this section.
 - .1 Provide all necessary controllers, display screens, trend logs as well as any other item as may be required to create, test and modify the control strategies.
 - .4 Provide all programming required to implement the control sequences described in this section.
 - .5 Programming style is to be of a form that enables the control strategies to be easily followed.
 - .1 Clarity, simplicity and elegance are more important than program size.
 - .6 Programs shall be modular in nature and shall be as structured as the language will permit.
 - .1 Unconditional “GOTO” statements shall be used sparingly and shall always jump forwards. All jumps from the body of a module shall target the end of that module. Similarly, jumps from the body of a sub-module shall target the end of that sub-module.
 - .2 All conditional "GOTO" statements, which make a single choice from multiple choice sub-module options, shall form the opening lines of code of the module. Each succeeding conditional jump shall direct the execution of software to the relevant sub-module which shall be in the reverse order of the conditional jump statement. The exit from each sub-module shall jump to the end of the module.
 - .3 All conditional "GOTO" statements, for "AND"/"OR" choices between sub-modules, shall form the opening line of code in each sub-module which the conditional statement controls.

- .7 All programs must include a sufficient number of comments to allow another person to make changes to the strategies at some later time.
- .8 Additional programming may be provided by the Contractor as desired, so long as it does not affect the intended operation of the specified sequences.
 - .1 Ensure that all equipment will operate in a safe manner.
- .9 Programming required for equipment safety may be installed by the Contractor as necessary.
 - .1 The Departmental Representative shall be notified of these changes as soon as practical.
- .10 All deviations from the specified programming, except those related to equipment safety, must receive prior written approval from the Departmental Representative.
- .11 All control loops shall be tuned such that they are stable through all seasons and operating conditions including start-up.
- .12 During the construction period through to the end of the warranty period, the Contractor shall be responsible for fine tuning the controls programming to ensure satisfactory operation.
 - .1 During this period the Contractor will also be responsible for any minor revisions requested by the Departmental Representative.
- .2 Miscellaneous Requirements
 - .1 Equipment status
 - .1 Annunciate status of all mechanical equipment equipped with a status feedback device.
 - .2 Alarms
 - .1 Annunciate alarms for all input status points for the following conditions:
 - .1 Equipment failure
 - .2 Failure to respond to commanded state
 - .3 State higher or lower than normal operating state
 - .4 Abnormal condition
 - .3 Setpoints
 - .1 All setpoints shall be readily and easily adjustable by the building operator
 - .4 Staggered Start of Motors
 - .1 Under all conditions of start-up, return from power failure, or panel reset, provide at least a 15 second delay between the time one motor starts and another is allowed to start.
 - .2 Refer also to emergency power mode start up in Division 26.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Expanded EMCS Sequences of Operation

1.4 EXPANDED EMCS SEQUENCES OF OPERATION

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 25 05 01 – EMCS General Requirements.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Using the Departmental Representative's general sequences of operations provided in this Section, expand on these written descriptions using the EMCS Contractor's own terminology and by including any additional controls or sub-sequences not indicated, to fully and accurately represent every aspect of the sequence as it will be programmed in the Building Management System.
 - .2 The intent of this submittal is not to simply copy and paste the Departmental Representative's sequence, but rather to expand upon the general sequences given and to correct or rewrite them as necessary to accurately represent the sequence as it will be programmed.
 - .2 Submittal Format
 - .1 Include Expanded Sequences of Operation on EMCS shop drawings on the schematic drawing for the respective equipment the sequence applies to.
 - .3 Submittal Procedure
 - .1 Ensure that all necessary sub-sequences or features that are not indicated in the general intent sequences of operations provided by the Departmental Representative are included in the updated sequences of operation (i.e. start-up checks, safety diagnostics, interlocks, etc.).

1.5 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Information Documents
 - .1 BMS Final Setpoints
 - .2 Operation and Maintenance Manuals Content

1.6 BMS FINAL SETPOINTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Update all initial setpoint parameters provided in the Expanded EMCS Sequences of Operations to indicate the final setpoint parameters as determined by the Contractor as the result of Equipment Start-Up,

Testing Adjusting and Balancing, Contractor's testing, or
Commissioning.

.2 Submittal Format

.1 Include

- .1 Final setpoints for all preliminary setpoints indicated in the sequences of operations.
- .2 Recommendations for additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 CONTROL SEQUENCES

- .1 Air Handling Units
- .2 Make-up Air Unit
- .3 Room Temperature Setpoints (for Cooling)
- .4 Room Temperature Setpoints (for Heating)

3.2 AIR HANDLING UNITS

- .1 Related Equipment
 - .1 Air Handling Units:
 - .1 AHU-1
 - .2 AHU-2
 - .3 AHU-6
 - .4 AHU-7
 - .5 AHU-8
- .2 Description
 - .1 Air handling systems provide ventilation and heating for areas served.
- .3 Operating Schedule
 - .1 Program an operable definable schedule for each air-handling system to determine occupancy mode – “occupied” or “unoccupied”.
 - .1 Initial Occupancy Schedule: Monday – Friday: 08:00 – 17:00
- .4 System Operation

- .1 Air Handling Unit Off
 - .1 The outside air damper, and return isolation dampers are closed
 - .2 The supply fan(s) are off
 - .3 The gas fired burner is off.
- .2 Air Handling Unit Start-up Sequence
 - .1 Open the return dampers fully
 - .2 When the dampers are confirmed to be open by end switch, start the supply fan.
- .3 Individual Fan Failure
 - .1 Monitor fan status of all fans - fan failure shall include:
 - .1 Loss of fan status
 - .2 On fan failure:
 - .1 Initiate Unit Stop Procedure
- .4 Low Temperature Shut Down
 - .1 Shut down the air handling unit when the mixed air temperature is less than the Low Limit Cut-Out Temperature
 - .1 Initial Low-Limit Cut-Out Temperature Setpoint:
 - .1 3 °C (adjustable)
 - .2 Shut-down shall occur regardless of the position of the hand-off operator selector switch.
 - .3 Fire/Life safety controls shall have priority over the freezestat control sequence (i.e. the air handling unit shall continue to operate regardless of plenum conditions if commanded by a fire/life safety control sequence).
 - .2 Locate the low temperature sensor/switch (freezestat):
 - .1 Within the mixed air plenum.
- .5 Unit Stop
 - .1 Stop the unit under the following conditions:
 - .1 Detection of low plenum temperature
 - .2 Loss of status of supply air fan
 - .3 Command override from EMCS
 - .4 Command from the fire alarm system
 - .2 On command of unit stop:
 - .1 Shut off gas fired burner
 - .2 Shut off supply fan
 - .3 Close return isolation dampers
 - .4 Close outside air damper
- .5 Temperature Control
 - .1 Heating Mode

- .1 If room temperature set point (refer to subsection 3.5) cannot be maintained for more than 20 minutes, system shall switch to heating mode.
- .2 Outdoor air dampers shall modulate to minimum position (to be confirmed during TAB). Return damper shall correspondingly modulate to maximum position.
- .3 Temperature Control: control the air handling unit by PID loop to maintain the room temperature set point
 - .1 System Warm-Up
 - .1 Operate the air handling unit for a 5 minute (adjustable) warm-up period with an elevated setpoint temperature.
 - .1 Warm-Up Supply Air Dry-Bulb Temperature: Initially set to +5 °C (adjustable) higher than the normal supply air dry-bulb temperature.
 - .2 Initial Supply Air Dry-Bulb Temperature: set to 30 °C (adjustable).
 - .1 Modify gains and sequences as required to control the initial supply air dry-bulb temperature to within +/- 1 °C of its setpoint.
 - .3 Modulate the gas fired burner to maintain the room temperature setpoint.
 - .2 Cooling Mode
 - .1 When system is not in heating mode it shall be in cooling mode.
 - .2 Temperature Control: control the air handling unit by PID loop to maintain the room temperature set point
 - .1 Modulate outdoor air and return air dampers to maintain room temperature set point.
- .6 Humidity Control
 - .1 Humidification
 - .1 There is a humidifier currently installed downstream of AS-1. The existing sequence of operations will be remain in place.
- .7 Monitoring
 - .1 Alarm Monitoring
 - .1 Lock out alarms when the unit is off.
 - .2 Annunciate an alarm through the BMS if:
 - .1 Low temperature (with manual reset)
 - .2 Fan drive status (with hand/off/auto)
 - .3 Fan failure (all fans) (with manual reset)
 - .2 Trend-Data Logging
 - .1 Provide trend-logging for the following:
 - .1 Supply air dry-bulb temperature

3.3 MAKE-UP AIR UNIT

- .1 Related Equipment
 - .1 Make-Up Air Unit:
 - .1 MAU-1
- .2 Description
 - .1 Air handling systems provide exhaust make-up air for areas served.
- .3 Operating Schedule
 - .1 Program an operable definable schedule for each air-handling system to determine occupancy mode – “occupied” or “unoccupied”.
 - .1 Initial Occupancy Schedule: Monday – Friday: 08:00 – 17:00
- .4 System Operation
 - .1 MAU-1 is to be interlocked with the Paint Booth Exhaust System
 - .2 Air Handling Unit Off
 - .1 The outside air damper, and return isolation dampers are closed
 - .2 The supply fan(s) are off
 - .3 The gas fired burner is off.
 - .3 Air Handling Unit Start-up Sequence
 - .1 Open the return dampers fully
 - .2 When the dampers are confirmed to be open by end switch, start the supply fan.
 - .4 Individual Fan Failure
 - .1 Monitor fan status of all fans - fan failure shall include:
 - .1 Loss of fan status
 - .2 On fan failure:
 - .1 Initiate Unit Stop Procedure
 - .5 Low Temperature Shut Down
 - .1 Shut down the air handling unit when the mixed air temperature is less than the Low Limit Cut-Out Temperature
 - .1 Initial Low-Limit Cut-Out Temperature Setpoint:
 - .1 3 °C (adjustable)
 - .2 Shut-down shall occur regardless of the position of the hand-off operator selector switch.
 - .3 Fire/Life safety controls shall have priority over the freezestat control sequence (i.e. the air handling unit shall continue to operate regardless of plenum conditions if commanded by a fire/life safety control sequence).
 - .2 Locate the low temperature sensor/switch (freezestat):
 - .1 Within the mixed air plenum.
 - .6 Unit Stop

- .1 Stop the unit under the following conditions:
 - .1 Detection of low plenum temperature
 - .2 Loss of status of supply air fan
 - .3 Command override from EMCS
 - .4 Command from the fire alarm system
- .2 On command of unit stop:
 - .1 Shut off gas fired burner
 - .2 Shut off supply fan
 - .3 Close return isolation dampers
 - .4 Close outside air damper
- .5 Temperature Control
 - .1 Control the air handling unit by PID loop to maintain the supply air dry-bulb temperature setpoint (DBT_{SA}):
 - .1 Supply Air Dry-Bulb Temperature: Initially set to 20 °C (adjustable).
 - .2 Modify gains and sequences as required to control the supply air dry-bulb temperature to within +/- 1 °C of its setpoint during all seasons and ambient conditions.
 - .2 System Warm-Up
 - .1 Operate the air handling unit for a 5 minute (adjustable) warm-up period with an elevated setpoint temperature.
 - .1 Warm-Up Supply Air Dry-Bulb Temperature: Initially set to +5 °C (adjustable) higher than the normal supply air dry-bulb temperature.
 - .3 Gas Fired Burner
 - .1 Modulate the gas fired burner to maintain the supply air dry-bulb temperature setpoint.
- .6 Monitoring
 - .1 Alarm Monitoring
 - .1 Lock out alarms when the unit is off.
 - .2 Annunciate an alarm through the BMS if:
 - .1 Low temperature (with manual reset)
 - .2 Fan drive status (with hand/off/auto)
 - .3 Fan failure (all fans) (with manual reset)

3.4 ROOM TEMPERATURE SETPOINTS (FOR COOLING)

- .1 System Operation
 - .1 Set the initial Room Setpoint Temperature for Cooling in accordance with the Room Setpoint Temperatures for Cooling Table.
 - .2 Room Setpoint Temperatures for Cooling Table:

Room/Area	Room Setpoint Temperature (for Cooling)
Room 124 Wood Shop	23°C
Room 125 Metal Shop	23°C
Room 131/117 Warehouse Assembly /Central Store	23°C
Room 133 Upholstery	23°C
Room 119 Paint Shop	23°C

3.5 ROOM TEMPERATURE SETPOINTS (FOR HEATING)

.1 System Operation

- .1 Set the initial Room Setpoint Temperature for Heating in accordance with the Room Setpoint Temperatures for Heating Table.
- .2 Room Setpoint Temperatures for Heating Table:

Room/Area	Room Setpoint Temperature (for Heating)	Room Setpoint Temperature (Nighttime Setback)
Room 124 Wood Shop	20°C	15°C
Room 125 Metal Shop	20°C	15°C
Room 131/117 Warehouse Assembly /Central Store	20°C	15°C
Room 133 Upholstery	20°C	15°C
Room 119 Paint Shop	20°C	15°C

END OF SECTION

SYSTEM: HEATING AHUs						
Applies to the following systems						
AHU-1						
AHU-2						
AHU-6						
AHU-7						
AHU-8						
MAU-1						
Description	Label	DI	DO	AI	AO	Notes
SPACE TEMPERATURE	SPTP	Tp				1
LOW TEMP ALARM	LT_A	Ta				1
OUTDOOR AIR DAMPER COMMAND	OAD_E		Dm			1
OUTDOOR AIR DAMPER STATUS (END SWITCH)	OAD_S	ES				1
SUPPLY AIR FLOW	SAVP			Pv		1
SUPPLY AIR TEMPERATURE	SAT			Tp		1
MINIMUM OUTDOOR AIR DAMPER COMMAND	OADMIN_E		Dm			1
MINIMUM OUTDOOR AIR DAMPER STATUS (END SWITCH)	OADMIN_S	ES				1
RETURN AIR DAMPER COMMAND	RAD_E		Dm			1
RETURN AIR DAMPER STATUS (END SWITCH)	RAD_S	ES				1
OUTDOOR AIR DAMPER CONTROL	SF03OAD_C		Dm			1
OUTDOOR AIR DAMPER STATUS	SF03OAD_S	ES				1
SUPPLY FAN START/STOP	SF03_E		Ry			1
SUPPLY FAN STATUS	SF03_S			Ri		1

Notes:

- Existing control point in BMS to be reused for new Air Handling Equipment.



Air Handling Unit Functional Test Report



Owner:			
Project:		P.N.:	
Location:		Tag:	
Description:		Room:	

General Requirements

- 1. Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- 2. Refer to Section 25 90 01 – EMCS Sequences of Operation for sequences of operation related to freezestats.

Specific Requirements

Commissioning Objectives

- A. Verify Pre-Heat and/or Cooling Coils’ Part Load Performance
- B. Verify Stroke for Outdoor, Return, and Exhaust Dampers
- C. Verify Minimum Outdoor Air Ventilation
- D. Verify Stroke for Control Valves
- E. Verify Heating Coil, Economizer, and Cooling Coil Operations
- F. Verify Supply and Return Fan Control
- G. Verify Discharge Air Temperature Set Point in All Operating Modes
- H. Verify Supply/Return Fan VFD Control Static Pressure Set Point
- I. Verify Safety Control Sequence and Integration
- J. Verify BAS Control Loop Stability

Pass
Y/N

Comments/Recommendations:

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 231 (R2001) Safety requirements for electrical equipment for measurement, control, and laboratory use.
 - .3 CAN3-C235-83 (R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.2 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.

1.3 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 Electrical equipment 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 Saskatchewan, Canada.
 - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Certificates:
 - .1 Provide CSA certified material and equipment.

-
- .2 Where CSA certified material or equipment is not available, submit such equipment or material to inspection authorities or authority having jurisdiction for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit, upon completion of work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .5 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

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 incorporation into manual.
 - .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.

1.5 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, in dry location, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect Electrical Equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Packaging Waste Management: remove for reuse by manufacturer and return of pallets, crates, padding, packaging materials as specified in Waste Reduction Workplan and Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 DESIGN REQUIREMENTS

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

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified equipment or material is not available, obtain special approval from authority having jurisdiction or inspection authorities before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of inspection authorities or authority having jurisdiction or Departmental Representative.
- .2 Decal or Porcelain enamel signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for copper conductors.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates or labels.
Identification to match with existing equipment.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, numbered, on both ends of phase conductors of feeders and branch circuit wiring.
Identification to match with existing equipment.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals. Identification to match with existing equipment.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.9 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

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 Electrical installation in accordance with manufacturer's written instructions.

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- .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.3 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.4 CONDUIT AND CABLE INSTALLATION

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

3.5 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

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- .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
 - .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .4 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
 - .3 Carry out tests in presence of Departmental Representative.
 - .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
 - .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - 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.

3.8 SYSTEM STARTUP

- .1 Instruct operating personnel and Departmental Representative in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.

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- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
 - .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes requirements for selective demolition and removal of electrical safety and security components including removal of conduit, junction boxes, and panels to source (home run removal) and incidentals required to complete work described in this Section.

1.2 REFERENCE STANDARDS

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

1.3 DEFINITIONS

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3 Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- .4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.
- .2 Scheduling: Account for Departmental Representative 's continued occupancy requirements during selective demolition and schedule staged occupancy and worksite activities as a defined Activity in Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Perform work of this Section in accordance with:
 - .1 Federal Workers' Compensation Service, Provincial/Territorial Workers' Compensation Boards/Commissions
 - .2 Government of Canada, Labour Program: Workplace Safety, Provincial/Territorial Occupational Health and Safety Standards and Programs

1.6 SITE CONDITIONS

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.
- .2 SPEC NOTE: Use the following paragraph when the hazardous substances report determines that the presence of any potentially hazardous and contaminated materials do not exist on site.
- .3 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform following activities:
 - .1 Refer to Section 01 41 00 - Regulatory Requirements for directives associated with specific material types.
 - .2 Hazardous substances will be as defined in Hazardous Products Act.
 - .3 Stop work in area of suspected hazardous substances.
 - .4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.
 - .5 Hazardous substances will be removed by Owner under a separate contract or as a change to Work.
 - .6 Proceed only after written instructions have been received from Departmental Representative.

1.7 SALVAGE AND DEBRIS MATERIALS

- .1 Demolished items become Contractor 's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Owner 's property.
- .2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials.

Part 2 Products

2.1 MATERIALS

- .1 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed.

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- .2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Departmental Representative will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

3.2 PREPARATION

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
- .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
 - .2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
 - .3 Prevent debris from blocking drainage inlets.
 - .4 Protect mechanical systems that will remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Departmental Representative and users is minimized and as follows:
- .1 Prevent debris from endangering safe access to and egress from occupied buildings.
 - .2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 EXECUTION

- .1 Demolition and Removal: Coordinate requirements as follows:
- .1 Disconnect electrical circuits and panel feeders; maintain electrical service and main distribution panel as is, ready for subsequent Work.
 - .2 Remove existing luminaires, electrical devices and equipment including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
 - .3 Perform demolition work in a neat and workmanlike manner:
 - .1 Remove tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.

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- .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.
 - .4 Disconnect panel feeders back to main distribution panel and re label respective circuit breaker as "SPARE".
 - .5 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
 - .6 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
 - .7 Grind off conduits and make flush with surface of concrete where conduits are cast into concrete; seal open ends of conduit with silicone sealant and leave in place.
 - .8 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

3.4 CLOSEOUT ACTIVITIES

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre).

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CAN/CSA-C22.2 No.18-98 (R2003), Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No.65-03 (R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 National Electrical Manufacturers Association (NEMA)

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 wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

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 wire and box connectors for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions and 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, off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return to manufacturer of crates, packaging materials as specified in Construction Waste Management Plan or Waste Reduction Workplan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper alloy, copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper alloy, copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 and NEMA to consist of:
 - .1 Connector body and stud clamp for conductors, copper
 - .2 Clamp for copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for non-metallic sheathed cable, flexible conduit, mineral insulated cable, armoured cable, TECK cable as required to: CAN/CSA-C22.2 No.18.

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 wire and box connectors installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

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

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.

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- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
 - .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

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

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketted.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type rated at 600 V.
- .4 Neutral supported cable: 3, 2, or 1 phase insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size as indicated. Type: NS90 Insulation: Type NSF-2 flame retardant rated 600 V.

2.2 NON-METALLIC SHEATHED CABLE

- .1 NMD90 cable shall not be used on this project.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform Megger tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

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- .6 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
 - .7 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

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 grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

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 grounding equipment for incorporation into manual.

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

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as indicated on drawings to electrically conductive underground water pipe.
- .2 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated on the drawings.
- .3 Insulated grounding conductors: green, copper conductors, size as indicated on the drawings.

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- .4 Non-corroding accessories necessary for grounding system, type, size, material as required, including but not necessarily limited to:
- .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Bonding jumpers, straps.
 - .5 Pressure wire connectors.

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 grounding equipment installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Install grounding resistance bank where required.
- .11 Bond single conductor, metallic armoured cables to cabinet at supply end and load end.

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- .12 Ground secondary service pedestals.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1, 24th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

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.
- .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 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction.
- .2 Single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished plaster walls.

2.3 CONDUIT BOXES

- .1 Cast FD, FS, aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.4 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

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 35 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 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .4 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .5 Identify systems for outlet boxes as required.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CAN/CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985 (R2003), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984 (R2003), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel, hot dipped galvanized steel, aluminum threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.

- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings, with expanded ends.
- .4 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal, aluminum, steel.
- .6 Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3.

2.2 CONDUIT FASTENINGS

- .1 One hole steel or malleable iron straps to secure surface conduits 50 mm and smaller.
 - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.8 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory “ells”; where 90 degrees bends for 25 mm and larger conduits.
- .3 Steel Type Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene

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 datasheets.

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in unfinished areas and in mechanical and electrical service rooms.
- .3 Surface mount conduits in Non Public Areas(back-of-house): Use electrical metallic tubing (EMT), unless otherwise noted..
- .4 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .5 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury except in cast concrete.
- .6 Use rigid pvc conduit in corrosive areas or underground.
- .7 Use flexible metal conduit for work in movable metal partitions or connection to motors in dry areas or connection to surface or recessed fluorescent fixtures or connection to recessed incandescent fixtures without prewired outlet box.
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .9 Use explosion proof flexible connection for connection to explosion proof motors.
- .10 Install conduit sealing fittings in hazardous areas.
 - .1 Fill with compound.
- .11 Minimum conduit size for lighting and power circuits: 19 mm.
- .12 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm diameter.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel.
 - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.
- .17 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .18 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.

- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On 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 CSA Group (CSA)
 - .1 CSA C22.2 No.29-11, Panelboards and Enclosed Panelboards.

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 panelboards 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 Saskatchewan, Canada.
 - .2 Include on drawings:
 - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

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 panelboards for incorporation into manual.

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 off ground, in dry location, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect panelboards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 250 V panelboards: bus and breakers rated for 22 KA (symmetrical) interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked enamel as per colour schedule, air dried enamel.
- .11 Isolated ground bus.
- .12 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.
- .13 Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules and Specifications;
 - Siemens or approved alternative by Eaton or Schneider."

2.2 BREAKERS

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplate for each panelboard size 4 engraved.

- .3 Nameplate for each circuit in distribution panelboards size 2 engraved.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

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 panelboards installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards in accordance with Section [06 10 53 - Miscellaneous Rough Carpentry]. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

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

-
- .2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

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 circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
 - .1 Prior to installation of circuit breakers in either new or existing installation, Contractor must submit 3 copies of a production certificate of origin from the manufacturer. Production certificate of origin must be duly signed by factory and local manufacturer's representative certifying that circuit breakers come from this manufacturer and are new and meet standards and regulations.
 - .1 Production certificate of origin must be submitted to Departmental Representative for approval.
 - .2 Delay in submitting production of certificate of origin will not justify any extension of contract and additional compensation.
 - .3 Any work of manufacturing, assembly or installation to begin only after acceptance of production certificate of origin Departmental Representative. Unless complying with this requirement, Departmental Representative reserves the right to mandate manufacturer listed on circuit breakers to authenticate new circuit breakers under the contract, and to Contractor's expense.
 - .4 Production certificate of origin must contain:
 - .1 Manufacturer's name and address and person responsible for authentication. Person responsible must sign and date certificate.
 - .2 Licensed dealer's name and address and person of distributor responsible for Contractor's account.
 - .3 Contractor's name and address and person responsible for project.
 - .4 Local manufacturer's representative name and address. Local manufacturer's representative must sign and date certificate.
 - .5 Name and address of building where circuit breakers will be installed:
 - .1 Project title
 - .2 End user's reference number

.3 List of circuit breakers

1.3 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 circuit breakers in dry location, indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect circuit breakers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers: 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 degrees C ambient.
- .3 Plug-in moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .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.

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 EXAMINATION

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

-
- .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install circuit breakers.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No.4-04 R2009, Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
 - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

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 disconnect switches - fused and non-fused 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: 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, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect disconnect switches - fused and non-fused from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Horsepower rated, Non-fusible disconnect switch in CSA enclosure to CAN/CSA-C22.2 No.4 size as indicated.
- .2 Provision for padlocking in on-off switch position by locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

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 disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Air Handling Unit Functional Test Report

Required Participants

Attendee	Name	Company	Req?	Initials
Commissioning Provider			<input type="checkbox"/>	
General Contractor			<input type="checkbox"/>	
Mechanical Contractor			<input type="checkbox"/>	
Controls Contractor			<input type="checkbox"/>	
TAB Contractor			<input type="checkbox"/>	
Architect			<input type="checkbox"/>	
Mechanical Consultant			<input type="checkbox"/>	
Electrical Consultant			<input type="checkbox"/>	
Owner			<input type="checkbox"/>	
Other			<input type="checkbox"/>	

Timing of Test

1. Perform test only after Pre-functional Checklists are complete.
2. Verify that central air handling unit and respective terminal units have been balanced.
3. Verify Air handler is fully operational, including all safeties and interlocks.
4. For Terminal Units equipped with hot water reheat, check:
 - 4.1. Hydronic piping is flushed and clean
 - 4.2. Heating water valve is balanced
 - 4.3. Pumps and heating plant are operating
5. Verify all control sequences are programmed per design intent.

Special Precautions

1. The following points should be noted to avoid testing complications:

Air Handling Unit Functional Test Report

- 1.1. Successful execution of the air handling system functional tests is dependent on the operation of ancillary equipment (including terminal units, chillers, boilers, and distribution pumps).
- 1.2. Discharge air temperature setpoint and reset schedules must be coordinated with the chilled and hot water temperature setpoints.
- 1.3. All resets, except the one being tested, should be overridden to prevent unwanted system interaction during testing.
- 1.4. Depending on when functional testing occurs, one or more control strategies may need to be tested during off-peak conditions (i.e. heating in summer and cooling in winter).
- 1.5. Proper execution of the supply fan flow control functional test requires functioning terminal units.
- 1.6. Indoor air quality may not be maintained without attention to achieving design outside air flow at part-load conditions.
- 1.7. A lack of attention to maintaining the desired pressure relationship between inside and outside conditions can have a large impact on infiltration.
- 1.8. Safety and interlock tests, as well as some test procedures and loop tuning efforts, could place the system at risk if the sequences do not function as intended.

Performance Requirements

Performance Requirement	Measured Value	Pass?
		<input type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>

Testing Procedure

A. Pre-Heat and/or Cooling Coils' Part Load Performance

Test Procedure	Response	Pass?
1. Verify that the pre-heat, heating, and/or cooling coil(s) meet the manufacturer's stated part load performance under the actual test conditions.		<input type="checkbox"/>

Comments/Recommendations:

Air Handling Unit Functional Test Report

Performed by:

Date:

Verified by:

Date:

B. Stroke for Outdoor, Return, and Exhaust Dampers

Test Procedure	Response	Pass?
1. Place BAS in occupied mode and verify the mixed air dampers modulate to the minimum outside air position.		<input type="checkbox"/>
2. While in the occupied mode, force BAS to read an outside air temperature below the economizer changeover value. 2.1. Verify that the mixed air dampers modulate so that the outside air dampers are opened past their minimum position as measured by the differential pressure transmitter (OA-RA).		<input type="checkbox"/>
3. Place BAS in unoccupied mode and verify that mixed air dampers modulate to the 100% return air position.		<input type="checkbox"/>
4. Force BAS to sense a temperature below the freezestat low limit. 4.1. Verify the mixed air dampers modulate to 100% return air position.		<input type="checkbox"/>
5. Override outdoor air damper to 0% and start unit from unoccupied. 5.1. Verify supply fan does NOT start until return air damper is verified open.		<input type="checkbox"/>

Comments/Recommendations:

Performed by:

Date:

Verified by:

Date:

Air Handling Unit Functional Test Report

C. Verify Minimum Outdoor Air Ventilation

Test Procedure	Response	Pass?
1. Verify outdoor air damper modulates to maintain TAB minimum outdoor airflow.		<input type="checkbox"/>
2. Verify the following: 2.1. When outdoor air temperature is above 55°F and return air enthalpy is lower than the outdoor air enthalpy, the return air damper and outdoor air damper are at minimum position, relief damper is closed, and return damper is open. 2.2. When outdoor air temperature is above 65°F, the outdoor air damper is at minimum, relief damper is closed, and return damper is open.		<input type="checkbox"/>

Comments/Recommendations:

Performed by:

Date:

Verified by:

Date:

D. Verify Stroke for Control Valves

Test Procedure	Response	Pass?
1. While in occupied mode, trip supply fan current sensor or de-energize via the disconnect switch. 1.1. Verify the heating control valve is 100% open, the cooling control valve is 100% closed.		<input type="checkbox"/>
2. Force BAS to sense a temperature below the freeze stat low limit. 2.1. Verify the heating control valve opens and the heating face and bypass dampers modulate to 100% open.		<input type="checkbox"/>

Comments/Recommendations:

Air Handling Unit Functional Test Report

Performed by:

Date:

Verified by:

Date:

E. Heating Coil, Economizer, and Cooling Coil Operations

Test Procedure	Response	Pass?
1. While in the occupied mode, force BAS into heating mode by increasing discharge air set point. 1.1. Verify that the mixed air dampers modulate so that the outside air dampers are at their minimum position and the heating valve and heating coil bypass damper modulate open.		<input type="checkbox"/>
2. While in the occupied mode, force BAS into cooling mode by decreasing discharge air set point and forcing the outside air damper to its minimum position. 2.1. Verify that the mixed air dampers modulate so that the outside air dampers are at their minimum position and the heating valve and heating coil bypass damper modulate open.		<input type="checkbox"/>
3. Adjust discharge air temperature as required. Allow unit to stabilize between variations and verify the following: 3.1. Outdoor damper, relief air damper, heating coil valve, and cooling coil valve operate in sequence to maintain discharge air set point.		<input type="checkbox"/>
4. Verify the following: 4.1. When outdoor air temperature is below 55 °F, dampers modulate to maintain supply air temperature of 55°F. 4.2. When outdoor air temperature is above 55°F and return air enthalpy is greater than the outdoor air enthalpy, the return air damper and outdoor air damper modulate for free cooling while maintaining discharge air temperature.		<input type="checkbox"/>

Comments/Recommendations:

Air Handling Unit Functional Test Report

Performed by:

Date:

Verified by:

Date:

F. Verify Supply and Return Fan Control

Test Procedure	Response	Pass?
1. Place BAS in occupied mode and verify that the supply fan starts followed by the return fan.		<input type="checkbox"/>
2. Place BAS in unoccupied mode and verify that the supply and return fans are de-energized.		<input type="checkbox"/>
3. Force all associated terminal unit space temperature readings below the occupied heating set point and set the time of day to the earliest warm-up mode time. 3.1. Verify that the supply and return fans are energized and the mixed air dampers remain in the 100% return air position while the heating section modulates to maintain discharge air temperature set point.		<input type="checkbox"/>
4. Force BAS to sense a temperature below the freeze stat low limit. 4.1. Verify that the supply and return fans are de-energized.		<input type="checkbox"/>

Comments/Recommendations:

Performed by:

Date:

Verified by:

Date:

G. Discharge Air Temperature Set Point in All Operating Modes

Test Procedure	Response	Pass?
1. While in the occupied mode, force BAS to read an outside air temperature at or above the maximum OAT utilized for the minimum SA temperature set point reset schedule (>5°F).		<input type="checkbox"/>

Air Handling Unit Functional Test Report

1.1. Verify that the supply air temperature set point resets downward in response to an increase in outside air temperature.		
2. While in the occupied mode, force BAS to read an outside air temperature at or below minimum OAT utilized for the maximum SA temperature set point reset schedule (<60°F). 2.1. Verify that the supply air temperature set point resets upward in response to a decrease in outside air temperature.		<input type="checkbox"/>

Comments/Recommendations:

Performed by:

Date:

Verified by:

Date:

H. Supply Fan VFD Control Static Pressure Set Point

Test Procedure	Response	Pass?
1. While in occupied mode, force associated terminal units closed until the static pressure is above set point. 1.1. Verify that supply and return air fan speeds decrease to maintain static pressure set point.		<input type="checkbox"/>
2. While in occupied mode, force associated terminal units open until the static pressure is below set point. 2.1. Verify that supply and return air fan speeds increase to maintain static pressure set point.		<input type="checkbox"/>
3. Force BAS to sense a static pressure above the high static set point. 3.1. Verify that the supply and return fans de-energize and a corresponding alarm is sent to the BAS.		<input type="checkbox"/>

Comments/Recommendations:

Air Handling Unit Functional Test Report

Performed by:

Date:

Verified by:

Date:

I. Safety Control Sequence and Integration

Test Procedure	Response	Pass?
1. While in the occupied mode, Force BAS to read a CO ₂ level above set point. 1.1. Verify that the mixed air dampers modulate open.		<input type="checkbox"/>
2. While in the occupied mode, Force BAS to read a CO ₂ level below set point. 3. Verify that the mixed air dampers modulate close.		<input type="checkbox"/>
4. Create Freezestat alarm and verify the following: 4.1. BMS alarm is generated. 4.2. Fans are OFF, outdoor air damper is CLOSED when temperature upstream of supply fan is below 37°F. Record Freezestat temperature alarm if different than 37°F.		<input type="checkbox"/>
5. Verify fans are OFF, outdoor air damper is CLOSED when return air temperature is above 300°F 5.1. Verify BMS alarm is generated.		<input type="checkbox"/>
6. Create smoke detection alarm and verify the following: 6.1. BMS alarm is generated. 6.2. Fans are OFF, outdoor air damper is CLOSED when smoke is detected.		<input type="checkbox"/>

Comments/Recommendations:

Performed by:

Date:

Verified by:

Date:

Air Handling Unit Functional Test Report

J. BAS Control Loop Stability

Test Procedure	Response	Pass?
1. Force the BAS to sense a differential static pressure reading across the pre-filter bank above the change out set point of 1 in wc. 1.1. Verify that a corresponding alarm is sent to the BAS.		<input type="checkbox"/>
2. While in occupied mode, trip return fan current sensor or de-energize via the disconnect switch. 2.1. Verify that the air handling unit continues to operate normally, and an alarm is sent to the BAS.		<input type="checkbox"/>
3. Force the BAS to sense a differential static pressure reading across the pre-filter bank above the change out set point of 1 in wc. 3.1. Verify that a corresponding alarm is sent to the BAS.		<input type="checkbox"/>

Comments/Recommendations:

Performed by:

Date:

Verified by:

Date:



Air Handler Operational Checklist

SNC • LAVALIN

Owner:

Project: P.N.:

Location: Tag:

Description:

Checked By: Date:

Verified By: Date:

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
Serial Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Type/Class	<input type="text"/>	<input type="text"/>	<input type="text"/>
Air Flow (L/s)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Location	<input type="text"/>	<input type="text"/>	<input type="text"/>
Area Served	<input type="text"/>	<input type="text"/>	<input type="text"/>
Panel Type	<input type="text"/>	<input type="text"/>	<input type="text"/>
Insulation type	<input type="text"/>	<input type="text"/>	<input type="text"/>
Profile	<input type="text"/>	<input type="text"/>	<input type="text"/>
Sound Reduction (dB)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Outside Air Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Supply Air Pre-Filter (Summer)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Supply Air Pre-Filter (Winter)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Heating Coil	<input type="text"/>	<input type="text"/>	<input type="text"/>
Reheat Coil	<input type="text"/>	<input type="text"/>	<input type="text"/>
Cooling Coil	<input type="text"/>	<input type="text"/>	<input type="text"/>
Supply Fan	<input type="text"/>	<input type="text"/>	<input type="text"/>
Heat Wheel	<input type="text"/>	<input type="text"/>	<input type="text"/>
Steam Humidifier	<input type="text"/>	<input type="text"/>	<input type="text"/>
Supply Air Final Filter	<input type="text"/>	<input type="text"/>	<input type="text"/>
Supply Air Discharge Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Return air Discharge Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Return Air Filter Type	<input type="text"/>	<input type="text"/>	<input type="text"/>
Return Fan	<input type="text"/>	<input type="text"/>	<input type="text"/>



Air Handler Operational Checklist

SNC • LAVALIN

Fan Vibration Isolation			
Acoustic Insulation			
Cooling Capacity (kW)			
Heat Output (Kw)			
Outside Air Flow (L/s)			
Voltage/Ph/Hz			
Emergency Power			

Operational Checks:

	OK?	COMMENTS
Pressure Leakage Test Complete	<input type="checkbox"/>	
Pressure Relief Valves Tested	<input type="checkbox"/>	
Disconnect Switch Tested	<input type="checkbox"/>	
Controls Point to Point Tested	<input type="checkbox"/>	
Actuator Spanned, Modulate Smoothly and Proportional to Input Signals and EMS Readout	<input type="checkbox"/>	
All Dampers Stroke Fully Without Binding	<input type="checkbox"/>	
Spans Calibrated and BAS Reading Site-Verified	<input type="checkbox"/>	
Valves Stroke Fully and Easily	<input type="checkbox"/>	
Valves Verified not to be Leaking Through Coils at Normal Operating Pressure	<input type="checkbox"/>	
Specified Point-to-Point Checks Tested	<input type="checkbox"/>	
Power Restoration Will not Over-Pressurize Duct from Closed FSD's	<input type="checkbox"/>	
HOA Switch Properly Operates the Unit	<input type="checkbox"/>	
Smoke Detector Tested to Shut Down Supply and Return Fans from Fire Alarm Panel	<input type="checkbox"/>	
Supply or Return Fan Will not Start up in Hand or Bypass Until dampers up and Downstream are Open	<input type="checkbox"/>	
Outdoor Air Sensor is Reporting Reliable Values	<input type="checkbox"/>	
Supply Air Temperature Sensor Reporting Reliable Values	<input type="checkbox"/>	
Mixed Air Temperature Sensor Reporting Reliable Values	<input type="checkbox"/>	
Return Air Temperature Sensor Reporting Reliable Values	<input type="checkbox"/>	
Specified Point-to-Point Check	<input type="checkbox"/>	



Air Handling Unit Static Test Report

SNC • LAVALIN

Owner:		
Project:		P.N.:
Location:		Tag:
Description:		Room:
Checked By:		Date:
Verified By:		Date:

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer			
Model #			
Serial Number			
Type/Class			
Air Flow (L/s)			
Location			
Area Served			
Panel Type			
Insulation type			
Profile			
Sound Reduction (dB)			
Outside Air Damper			
Supply Air Pre-Filter (Summer)			
Supply Air Pre-Filter (Winter)			
Heating Coil			
Reheat Coil			
Cooling Coil			
Supply Fan			
Heat Wheel			
Steam Humidifier			
Supply Air Final Filter			
Supply Air Discharge Damper			
Return air Discharge Damper			
Return Air Filter Type			
Return Fan			



Air Handling Unit Static Test Report

SNC • LAVALIN

Fan Vibration Isolation			
Acoustic Insulation			
Cooling Capacity (kW)			
Heat Output (Kw)			
Outside Air Flow (L/s)			
Voltage/Ph/Hz			
Emergency Power			

Installation Checks:

	OK?	COMMENTS
Mounting/Support System	<input type="checkbox"/>	
Cabinet and General Installation	<input type="checkbox"/>	
Casing Condition Checked	<input type="checkbox"/>	
Access Doors Close Tightly	<input type="checkbox"/>	
Vibration Isolation	<input type="checkbox"/>	
Seismic Restraints	<input type="checkbox"/>	
Equipment Guards	<input type="checkbox"/>	
Flexible Connections	<input type="checkbox"/>	
Sound Attenuation Installed	<input type="checkbox"/>	
Boot Between Duct and Unit	<input type="checkbox"/>	
Duct Joint Sealant Properly Installed	<input type="checkbox"/>	
Branch Duct Control Dampers Operable	<input type="checkbox"/>	
Balancing Dampers Installed	<input type="checkbox"/>	
Temporary Start-up Filters	<input type="checkbox"/>	
Fire & Balance Dampers	<input type="checkbox"/>	
Insulation Installed Properly	<input type="checkbox"/>	
Drain Pans Checked	<input type="checkbox"/>	
Outside Air Dampers	<input type="checkbox"/>	
Return Air Dampers	<input type="checkbox"/>	
Mixed Air Dampers	<input type="checkbox"/>	
Humidifier Checked	<input type="checkbox"/>	
Filter Bank Checked	<input type="checkbox"/>	
DP Switch Gauge	<input type="checkbox"/>	
Motor Rated for VSD Service	<input type="checkbox"/>	
Sensors Calibrated	<input type="checkbox"/>	
Temperature Gages Checked	<input type="checkbox"/>	
Pressure Control checked	<input type="checkbox"/>	
Humidity Control Checked	<input type="checkbox"/>	
Unit Identification	<input type="checkbox"/>	
Monorails	<input type="checkbox"/>	
Overload Protection	<input type="checkbox"/>	



Air Terminals Static Test Report

SNC • LAVALIN

Owner:		
Project:		P.N.:
Location:		Tag:
Description:		
Checked By:		Date:
Verified By:		Date:

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer			
Model #			
Serial Number			
Type/Class			
Air Flow (l/s)			
Static Pressure (Pa)			
Voltage/Ph/Hz			
Emergency Power			

Installation Checks:

	OK?	COMMENTS
Inspect all air terminals for proper fit into ceiling materials	<input type="checkbox"/>	
Ensure air terminal trim overlaps plaster line in drywall plaster ceiling	<input type="checkbox"/>	
Inspect lay-in T-bar or concealed spline systems	<input type="checkbox"/>	
Verify air terminals are installed flush with finished ceiling	<input type="checkbox"/>	
Check adjustable diffusers for opening and closing	<input type="checkbox"/>	

Return Fan Operational Test Report

Owner:

Project: **P.N.:**

Location: **Tag:**

Description:

Checked By: **Date:**

Verified By: **Date:**

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
Serial Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Type/Class	<input type="text"/>	<input type="text"/>	<input type="text"/>
MCC Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Back Draft Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Air Flow (L/s)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Static Pressure (Pa)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Back Draft Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Magnetic Starter	<input type="text"/>	<input type="text"/>	<input type="text"/>
Bearing Type	<input type="text"/>	<input type="text"/>	<input type="text"/>
Belt Size/Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Pulley Size/Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Thrust Absorbers	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD HP Rating	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD Voltage Rating	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor VFD Rated	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor Size (kW)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor RPM	<input type="text"/>	<input type="text"/>	<input type="text"/>
Voltage/Ph/Hz	<input type="text"/>	<input type="text"/>	<input type="text"/>
Emergency Power	<input type="text"/>	<input type="text"/>	<input type="text"/>



Return Fan Operational Test Report

Operational Checks:

	OK?	COMMENTS
Return Fan Rotation Correct	<input type="checkbox"/>	
Return Fan and Motor alignment	<input type="checkbox"/>	
Return Fan Tension	<input type="checkbox"/>	
Return Fan Acceptable Noise and Vibration	<input type="checkbox"/>	
Interlocks Verified	<input type="checkbox"/>	
Pulleys Aligned	<input type="checkbox"/>	
Freedom of Rotation	<input type="checkbox"/>	
Electrical Interlocks Verified	<input type="checkbox"/>	
Disconnect Switch Functional	<input type="checkbox"/>	

Return Fan Static Test Report

Owner:		
Project:		P.N.: <input type="text"/>
Location:		Tag: <input type="text"/>
Description:		Room: <input type="text"/>
Checked By:		Date: <input type="text"/>
Verified By:		Date: <input type="text"/>

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer			
Model #			
Serial Number			
Type/Class			
MCC Number			
Back Draft Damper			
Air Flow (L/s)			
Static Pressure (Pa)			
Back Draft Damper			
Magnetic Starter			
Bearing Type			
Belt Size/Number			
Pulley Size/Number			
Thrust Absorbers			
VFD Manufacturer			
VFD Model #			
VFD HP Rating			
VFD Voltage Rating			
Motor Manufacturer			
Motor Model #			
Motor VFD Rated			
Motor Size (kW)			
Motor RPM			
Voltage/Ph/Hz			
Emergency Power			



Return Fan Static Test Report

Installation Checks:

	OK?	COMMENTS
Fan Housing	<input type="checkbox"/>	
Acoustic Insulation	<input type="checkbox"/>	
Seismic Restraints	<input type="checkbox"/>	
Equipment Guards Installed	<input type="checkbox"/>	
Mountings Installed Properly	<input type="checkbox"/>	
Vibration Isolators Installed	<input type="checkbox"/>	
Unit Identification	<input type="checkbox"/>	
Permanent Labels Affixed	<input type="checkbox"/>	
Interlocks Verified	<input type="checkbox"/>	
Back Draft Dampers Installed	<input type="checkbox"/>	
Overload Heaters Installed	<input type="checkbox"/>	
Unit Identification	<input type="checkbox"/>	
Silencer	<input type="checkbox"/>	
Return Fan Protective Shrouds	<input type="checkbox"/>	
Return Fan Motor Lubricated	<input type="checkbox"/>	
Overload Protection	<input type="checkbox"/>	

Supply Fan Operational Test Report

Owner:

Project: **P.N.:**

Location: **Tag:**

Description:

Checked By: **Date:**

Verified By: **Date:**

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
Serial Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Type/Class	<input type="text"/>	<input type="text"/>	<input type="text"/>
MCC Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Back Draft Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Air Flow (L/s)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Static Pressure (Pa)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Back Draft Damper	<input type="text"/>	<input type="text"/>	<input type="text"/>
Magnetic Starter	<input type="text"/>	<input type="text"/>	<input type="text"/>
Bearing Type	<input type="text"/>	<input type="text"/>	<input type="text"/>
Belt Size/Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Pulley Size/Number	<input type="text"/>	<input type="text"/>	<input type="text"/>
Thrust Absorbers	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD HP Rating	<input type="text"/>	<input type="text"/>	<input type="text"/>
VFD Voltage Rating	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor Manufacturer	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor Model #	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor VFD Rated	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor Size (kW)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Motor RPM	<input type="text"/>	<input type="text"/>	<input type="text"/>
Voltage/Ph/Hz	<input type="text"/>	<input type="text"/>	<input type="text"/>
Emergency Power	<input type="text"/>	<input type="text"/>	<input type="text"/>



Supply Fan Operational Test Report

Operational Checks:

	OK?	COMMENTS
Return Fan Rotation Correct	<input type="checkbox"/>	
Return Fan and Motor alignment	<input type="checkbox"/>	
Return Fan Tension	<input type="checkbox"/>	
Return Fan Acceptable Noise and Vibration	<input type="checkbox"/>	
Interlocks Verified	<input type="checkbox"/>	
Pulleys Aligned	<input type="checkbox"/>	
Freedom of Rotation	<input type="checkbox"/>	
Electrical Interlocks Verified	<input type="checkbox"/>	
Disconnect Switch Functional	<input type="checkbox"/>	

Supply Fan Static Test Report

Owner:		
Project:		P.N.: <input type="text"/>
Location:		Tag: <input type="text"/>
Description:		Room: <input type="text"/>
Checked By:		Date: <input type="text"/>
Verified By:		Date: <input type="text"/>

Technical Data:

	SPECIFIED	SHOP DRAWINGS	INSTALLED
Manufacturer			
Model #			
Serial Number			
Type/Class			
MCC Number			
Back Draft Damper			
Air Flow (L/s)			
Static Pressure (Pa)			
Back Draft Damper			
Magnetic Starter			
Bearing Type			
Belt Size/Number			
Pulley Size/Number			
Thrust Absorbers			
VFD Manufacturer			
VFD Model #			
VFD HP Rating			
VFD Voltage Rating			
Motor Manufacturer			
Motor Model #			
Motor VFD Rated			
Motor Size (kW)			
Motor RPM			
Voltage/Ph/Hz			
Emergency Power			



Supply Fan Static Test Report

Installation Checks:

	OK?	COMMENTS
Fan Housing	<input type="checkbox"/>	
Acoustic Insulation	<input type="checkbox"/>	
Seismic Restraints	<input type="checkbox"/>	
Equipment Guards Installed	<input type="checkbox"/>	
Mountings Installed Properly	<input type="checkbox"/>	
Vibration Isolators Installed	<input type="checkbox"/>	
Unit Identification	<input type="checkbox"/>	
Permanent Labels Affixed	<input type="checkbox"/>	
Interlocks Verified	<input type="checkbox"/>	
Back Draft Dampers Installed	<input type="checkbox"/>	
Overload Heaters Installed	<input type="checkbox"/>	
Unit Identification	<input type="checkbox"/>	
Silencer	<input type="checkbox"/>	
Supply Fan Protective Shrouds	<input type="checkbox"/>	
Supply Fan Motor Lubricated	<input type="checkbox"/>	
Overload Protection	<input type="checkbox"/>	