



SPECIFICATION (Issued for Construction, 11 June 2018)

Suite 483, 1091 Portage Avenue
Renovation and Fit-Up
Winnipeg, Manitoba
Public Services and Procurement Canada (PSPC)
Project No. R.076524.002



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Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract comprises demolition and architectural, structural, mechanical, electrical and telecommunications work associated with renovation and fit-up of a dispatch and communications centre located at 1091 Portage Avenue, Winnipeg, Manitoba. Work also includes construction of a new electrical room in the basement of the building; and supply and installation of a new generator and pad in the existing parking lot.

1.2 CONTRACT METHOD

- .1 Construct Work under stipulated price contract.

1.3 LAWS, NOTICES, PERMITS AND FEES

- .1 The Departmental Representative shall apply and pay for the building permit. Contactor is to pick up the building permit from the Planning Office.
- .2 The Contractor shall be responsible for other permits, licenses, and certificates necessary for the performance of the Work that were in force at the date of executing the Agreement.
- .3 Submit work permits to Building Operations Representative minimum 48 hours prior to performance of affiliated work.

1.4 WORK BY OTHERS

- .1 Co-operate with other Contractors in carrying out their respective works and carry out instructions from Departmental Representative.
- .2 Co-ordinate Work with that of other Contractors. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Departmental Representative, in writing, defects that may interfere with proper execution of Work.

1.5 FUTURE WORK

- .1 Project is designed for protection of new equipment for future piping installation. This includes isolation valves and filtration devices. Coordinate with Departmental Representative.

1.6 WORK SEQUENCE

- .1 Construct Work in stages to accommodate continued use and occupancy of premises during construction.
- .2 Coordinate Progress Schedule and coordinate with occupancy during construction.
 - .1 Provide GANTT Chart as specified in Section 01 32 16 – Construction Progress Schedule – Bar (GANTT) Chart.

- .3 Work sequence:
 - .1 Construct demising walls before performing other Work of the Contract. Fully finish walls on the side of the adjacent suite.
 - .2 Construct full fit-up of Rooms 479A, 479B, and 483, including installation of raised access flooring.
 - .3 Fit-up remaining tenant space.
- .4 Maintain fire access/control.

1.7 FULL OCCUPANCY

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

1.8 CONTRACTOR USE OF PREMISES

- .1 Limit use of premises for Work and for access, to allow full occupancy. Refer to Section 01 14 00 – Work Restrictions.
- .2 Co-ordinate use of premises under direction of Departmental Representative.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work that remain.
- .5 Repair or replace portions of existing work that have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.
- .6 Condition of existing work at completion of operations: Equal to or better than that which existed before new work started.

1.9 DEPARTMENTAL REPRESENTATIVE-PROVIDED ITEMS

- .1 Departmental Representative Responsibilities:
 - .1 Arrange for delivery of shop drawings, product data, samples, manufacturer's instructions, and certificates to Contractor.
 - .2 Deliver supplier's bill of materials to Contractor.
 - .3 Arrange and pay for delivery to site in accordance with Progress Schedule.
 - .4 Inspect deliveries jointly with Contractor.
 - .5 Submit claims for transportation damage.
 - .6 Arrange for replacement of damaged, defective or missing items.
 - .7 Arrange for manufacturer's field services; arrange for and deliver manufacturer's warranties and bonds to Contractor.
- .2 Contractor Responsibilities:

- .1 Designate submittals and delivery date for each product in progress schedule.
- .2 Review shop drawings, product data, samples, and other submittals. Submit to Departmental Representative notification of observed discrepancies or problems anticipated due to non-conformance with Contract Documents.
- .3 Receive and unload products at site.
- .4 Inspect deliveries jointly with Departmental Representative; record shortages, and damaged or defective items.
- .5 Handle products at site, including uncrating and storage.
- .6 Protect products from damage, and from exposure to elements.
- .7 Assemble, install, connect, adjust, and finish products.
- .8 Provide installation inspections required by public authorities.
- .9 Repair or replace items damaged by Contractor or subcontractor on site (under their control).

1.10 DOCUMENTS REQUIRED

- .1 Successful bidding Contractor is to obtain required sets of Contract Documents for construction purposes, which includes two (2) sets for "as-built" and record purposes.
 - .1 Contractor is responsible for costs of printing, handling, and shipping of Contract Documents.
- .2 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.
 - .9 Copy of Approved Work Schedule.
 - .10 Health and Safety Plan and Other Safety Related Documents.
 - .11 Other documents as specified.

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.
- .2 Ingress and egress of Contractor vehicles at site is limited to loading dock at rear of building. Coordinate with Departmental Representative.

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 Regular working hours for the building are 8:00 am to 4:00 pm, Monday to Friday.
- .3 Maintain existing services to building and provide for personnel and vehicle access.
- .4 Operations of building occupants may delay or stop construction activities at any time.
- .5 Access to area of Work:
 - .1 Access to area of the Work will be via the Freight Elevator at the building's northwest corner, then south through the 4th Floor hallway.
 - .2 Accept liability for damage to hallways caused by activities of the Work.
 - .3 Access to areas outside of the area of Work is not permitted unless coordinated, approved, and communicated with the Departmental Representative, building occupants, and project management team.
 - .4 Ensure area between loading dock and Work site are kept free and clean of demolition and construction dirt and debris.
- .6 Use only the freight elevator located at the northwest corner of the building for moving workers and material.
 - .1 Protect walls of elevator, to approval of Departmental Representative, prior to use.
 - .2 Accept liability for damage, safety of equipment and overloading of existing equipment.
 - .3 Removal and off-loading of waste materials, tools, and equipment may be required to be performed outside of regular working hours as directed by Departmental Representative.
- .7 Noisy work: Perform noise-generating work outside of regular building operation hours, including coring and hammer drilling.

- .1 Provide 72 hours' notice to and coordinate performance of noisy work with Departmental Representative.
- .8 Departmental Representative will assign sanitary facilities for use by Contractor's personnel.
 - .1 Use of washrooms in Basement is permitted.
 - .2 Perform condition reports of assigned washrooms with Departmental Representative before and after construction.
 - .3 Accept liability for damage or deterioration of washroom facilities.
- .9 Closures: Protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute work with least possible interference or disturbance to building operations, occupants, 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 7 days' 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.
- .3 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.
- .4 Submit schedule and obtain approval from Departmental Representative for shutdown or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .5 Provide temporary services when directed by Departmental Representative to maintain critical building and tenant systems.
- .6 Provide adequate bridging over trenches that cross sidewalks or roads to permit normal traffic.
- .7 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .8 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .9 Record locations of maintained, re-routed, and abandoned service lines.
- .10 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 SPECIAL REQUIREMENTS

- .1 Perform Work during normal working hours of the facility.
- .2 Work performed outside of normal operating hours is to be kept to a minimum. Co-ordinate with Departmental Representative to obtain Tenant's permission to perform work outside of normal working hours. Refer to Security requirements in this Section.
- .3 Submit schedule in accordance with Section 01 32 16 - Construction Progress Schedule - Bar (GANTT) Chart.
- .4 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic, and security regulations.
- .5 Keep within limits of work and avenues of ingress and egress.

1.6 SECURITY

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
- .2 Obtain services of Tenant-approved security escort from Canadian Corps of Commissionaires. Security escort is required on site at all times during performance of the Work.
- .3 Security clearances:
 - .1 Contractor's personnel will require satisfactory RCMP-initiated security screening to complete Work in premises and on site.
 - .2 Submit completed RCMP Security Requirements Check List (SRCL) Forms at project start-up meeting. One form is required for each person requiring access to project site. Required SRCL will be provided at start-up meeting.
 - .3 Personnel will be checked in daily at start of work shift and provided with pass that must be worn at all times. Pass must be returned at end of work shift, and personnel checked out.

1.7 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions.
- .2 Smoking is not permitted inside building.
- .3 Confirm, with Departmental Representative, outdoor locations where smoking is permitted.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting four days in advance of meeting date to Departmental Representative.
- .4 Provide physical space and make arrangements for meetings.
- .5 Preside at meetings.
- .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within three days after meetings and transmit to Departmental Representative, meeting participants, and 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 PRE-CONSTRUCTION MEETING

- .1 Within 10 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum five 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 Submittal of Security Requirements Check List (SRCL) Forms: in accordance with Section 01 14 00 – Work Restrictions.
 - .3 Schedule of Work: in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .4 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .5 Requirements for temporary facilities, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .6 Provision of shop drawings for dispatch consoles, raised access flooring, and generators at time of start-up meeting.

- .7 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
- .8 Coordination of Work of this contract with work of other Contractors.
- .9 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
- .10 Departmental Representative-provided products.
- .11 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .12 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .13 Take-over procedures and acceptance in accordance with Section 01 78 00 - Closeout Submittals.
- .14 Appointment of inspection and testing agencies or firms.

1.3 PROGRESS MEETINGS

- .1 During course of Work and two weeks prior to project completion, schedule progress meetings bi-weekly.
- .2 Contractor, major Subcontractors involved in Work, and Departmental Representative are to be in attendance.
- .3 Notify parties minimum three days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within three 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 that impede construction schedule.
 - .5 Coordination of Work of this contract with work of other Contractors.
 - .6 Review of off-site fabrication delivery schedules.
 - .7 Corrective measures and procedures to regain projected schedule.
 - .8 Revision to construction schedule.
 - .9 Progress schedule for succeeding work period, minimum 2 weeks.
 - .10 Review submittal schedules; expedite as required.
 - .11 Maintenance of quality standards.
 - .12 Review proposed changes for affect on construction schedule and on completion date.
 - .13 Other business.

1.4 COORDINATION MEETINGS

- .1 Attend coordination meetings with Departmental Representative and other Contractors as required to coordinate construction operations and ensure efficient and orderly installation of each part of Work, including portions of the construction that depend on each other for proper installation, connection, and operation.
 - .1 Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - .2 Coordinate installation of different components with other Contractors to ensure maximum accessibility for required maintenance, service and repair, and resolve differences or disputes between subcontractors and their relationships with the Work.
 - .3 Made adequate provisions to accommodate items scheduled for later installation.
- .2 Coordinate scheduling and timing of required administrative procedures with other construction activities and the activities of other Contractors to avoid conflicts and to ensure orderly progress of the Work.
- .3 If necessary for the proper execution of the Work, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports and list of attendees at meetings.

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 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 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to Departmental Representative, within 10 working days of Award of Contract, Bar (GANTT) Chart as Master Plan for planning, monitoring, and reporting of project progress.
- .3 Submit Project Schedule to Departmental Representative within 5 working days of receipt of acceptance of Master Plan.
- .4 Submit forecasting schedule to Departmental Representative at progress meetings, covering the anticipated schedule for the following two weeks.

1.4 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.

1.5 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 Demolition.
 - .6 Erection of 4th Floor demising wall.
 - .7 Completion of fit-up in Rooms 479A, 479B, and 483, including installation of raised access flooring.
 - .8 Dispatch console installation.
 - .9 Interior Architecture (Walls, Floors and Ceiling).
 - .10 Millwork.
 - .11 Appliance installation.
 - .12 Furniture installation (by Others).
 - .13 Plumbing.
 - .14 Lighting.
 - .15 Electrical.
 - .16 Generator installation and affiliated site work.

- .17 Piping.
- .18 Controls.
- .19 Heating, Ventilating, and Air Conditioning.
- .20 Fire Systems.
- .21 Testing and Commissioning.

1.6 PROJECT SCHEDULE REPORTING

- .1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.
- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.7 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.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Provide submittals listed for review to Departmental Representative. 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 for 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 at time of submission, in writing, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.
- .10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data that are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Where required, submit drawings stamped and signed by professional engineer registered or licensed in Manitoba.
- .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 working 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's review, distribute copies.
- .10 Submit electronic copies 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 Material Safety Data Sheets concerning impedances, hazards and safety precautions.
 - .15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
 - .17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
 - .18 Delete information not applicable to project.
 - .19 Supplement standard information to provide details applicable to project.
 - .20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
 - .21 The review of shop drawings by Public Services and Procurement Canada (Departmental) is for sole purpose of ascertaining conformance with general concept.

- .1 This review shall not mean that Departmental 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 business address.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern, or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples that 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, as directed by Departmental Representative.
- .2 Project identification: Name and number of project, and date of exposure indicated.
- .3 Number of viewpoints: 4 locations.
 - .1 Viewpoints and their location as determined by Departmental Representative.
- .4 Frequency of photographic documentation: Weekly, and as directed by Departmental Representative.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations.
- .2 Province of Manitoba
 - .1 The Workplace Safety and Health Act RSM 1987, including latest updates and amendments.

1.2 SAFETY PLAN

- .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.

1.3 RESPONSIBILITY

- .1 The "Prime Contractor" according applicable local jurisdiction, is 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.
- .3 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, and follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction. Advise Departmental Representative verbally and in writing.

1.4 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan within 7 working days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site-specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit copies of Contractor's authorized representative's work site health and safety inspection reports weekly to Departmental Representative.

- .4 Submit copies of reports or directions issued by Federal and Provincial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit two copies of WHMIS MSDS to Departmental Representative for each hazardous material required prior to bringing hazardous material on site.
- .7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 10 working days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 5 working days after receipt of comments from Departmental Representative.
- .8 Departmental Representative 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.

1.5 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.
- .2 Install proper site separation and identification in order to maintain time and space at all times throughout life of project.

1.6 SAFETY ASSESSMENT

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

1.7 MEETINGS

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

1.8 REGULATORY REQUIREMENTS

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

1.9 PROJECT/SITE CONDITIONS

- .1 Work at site may involve contact with asbestos-containing materials.
 - .1 Hazardous material inventory will be provided by Departmental Representative at project start-up meeting.

1.10 COMPLIANCE REQUIREMENTS

- .1 Comply with The Workplace Safety and Act, Workplace Safety and Health Regulation, Manitoba Reg. 217.
- .2 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

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

1.12 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:
 - .1 Have working knowledge of occupational safety and health regulations.
 - .2 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
 - .3 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
 - .4 Be on site during execution of Work, and report directly to and be under direction of Certified Industrial Hygienist site supervisor.

1.13 POSTING OF DOCUMENTS

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

1.14 WHMIS - MSDS

- .1 Ensure that products used in project comply with Workplace Hazardous Materials Information System (WHMIS) Regulations and Chemical Substances of the OH&S Act and Regulations regarding use, handling, labelling, storage, and disposal of hazardous materials.
- .2 Deliver copies of relevant Material Safety Data Sheets (MSDS) to job site and Departmental Representative. MSDS to be acceptable to Labour Canada and Health and Welfare Canada for controlled products that will be used in performance of this work. Locate MSDS in accessible locations for workers and visitors throughout the site, bound and organized in binders.

- .3 Train workers required to use or to work near controlled products in accordance with OH&S Act and Regulations.
- .4 Label controlled products at jobsite in accordance with OH&S and Regulations and WHMIS.
- .5 Provide appropriate emergency facilities as specified in the MSDS where workers might be exposed to contact with chemicals, including eye-wash facilities, emergency shower.
 - .1 Workers are to be trained in use of such emergency equipment.
- .6 Provide appropriate personal protective equipment as specified in the MSDS where workers are required to use controlled products.
 - .1 Properly fit workers for personal protective equipment
 - .2 Train workers in care, use, and maintenance of personal protective equipment.
- .7 No controlled products are to be brought on-site without prior approved MSDS.
- .8 MSDS are to remain on site at all times.

1.15 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.

1.16 BLASTING

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

1.17 POWDER ACTUATED DEVICES

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

1.18 WORK STOPPAGE

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

1.19 FIRE PROTECTION

- .1 Comply with requirements of the local Fire Commissioner's Office.
- .2 Provide and maintain temporary fire protection equipment during performance of Work required by governing codes, regulations and bylaws.
- .3 Burning rubbish and construction waste materials is not permitted on site.

- .4 Maintain placed or installed fire resistive construction to protect the portions of the Work during construction.

END OF SECTION

Part 1 General

1.1 REFERENCES AND CODES

- .1 Perform Work in accordance with 2010 National Building Code of Canada (NBC) including amendments up to tender closing date, and other codes of provincial or local application; in case of conflict or discrepancy, more stringent requirements apply. The following governing standards are also to apply.
 - .1 Canadian Electrical Code, CSA C22.1-09.
 - .2 National Plumbing Code of Canada, 2010.
 - .3 National Fire Code of Canada, 2010.
- .2 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.2 HAZARDOUS MATERIAL DISCOVERY

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

1.3 BUILDING SMOKING ENVIRONMENT

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

END OF SECTION

Part 1 General

1.1 INSPECTION

- .1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers, or permits to be covered, Work that has been designated for special tests, inspections, or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination, such work is found not in accordance with Contract Documents, correct Work and pay cost of examination and correction. If Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement.

1.2 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies may be engaged by Departmental Representative for purpose of inspecting and testing portions of Work. Cost of such services will be borne by Departmental Representative.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and testing, appointed agency will request additional inspection and testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and re-inspection.

1.3 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.4 PROCEDURES

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

- .2 Submit samples and materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.5 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If, in opinion of Departmental Representative, it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative.

1.6 REPORTS

- .1 Submit three print copies and one electronic copy of inspection and test reports to Departmental Representative.
- .2 Provide copies to subcontractor of work being inspected or tested and manufacturer or fabricator of material being inspected or tested.

1.7 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as requested.
- .2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Departmental Representative and may be authorized as recoverable.

1.8 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of Sections required to provide mock-ups.
- .2 Construct in locations acceptable to Departmental Representative.
- .3 Prepare mock-ups for Departmental Representative's review with reasonable promptness and in orderly sequence, to not cause delays in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension because of such default will be allowed.
- .5 If requested, Departmental Representative will assist in preparing schedule-fixing dates for preparation.

- .6 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

1.9 MILL TESTS

- .1 Submit mill test certificates as requested, and as required of specification Sections.

1.10 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical, and building equipment systems.
- .2 Refer to Section 01 91 31 – Commissioning Plan for definitive requirements.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA S269.2-M87 (R2003), Access Scaffolding for Construction Purposes.
 - .2 CAN/CSA Z321-96 (R2006), Signs and Symbols for the Workplace.

1.2 SUBMITTALS

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

1.3 INSTALLATION AND REMOVAL

- .1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .2 Indicate use of supplemental or other staging area.
- .3 Provide construction facilities to execute work expeditiously.
- .4 Remove from site all such work after use.

1.4 SCAFFOLDING

- .1 Scaffolding in accordance with CSA S269.2.
- .2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms, temporary stairs.

1.5 ELEVATORS

- .1 Designated existing elevators are to be used by construction personnel and transporting of materials. Co-ordinate use with Departmental Representative.
- .2 Provide protective coverings for finish surfaces of cars and entrances.

1.6 SITE STORAGE/LOADING

- .1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.
- .2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

1.7 CONSTRUCTION PARKING

- .1 Parking will not be permitted on site.
- .2 Provide and maintain adequate access to project site.

1.8 EQUIPMENT, TOOL AND MATERIALS STORAGE

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

1.9 CONSTRUCTION SIGNAGE

- .1 Signs and notices for safety and instruction in both official languages; graphic symbols to CAN/CSA Z321.
- .2 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Departmental Representative.

1.10 CLEAN-UP

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

END OF SECTION

Part 1 General

1.1 INSTALLATION AND REMOVAL

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

1.2 DUST TIGHT SCREENS

- .1 Provide dust tight screens or partitions to localize dust-generating activities, and for protection of workers, finished areas of Work, and User Department.
- .2 Maintain and relocate protection until such work is complete.

1.3 ACCESS TO SITE

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

1.4 FIRE ROUTES

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

1.5 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

1.6 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 locations and installation schedule with Departmental Representative, minimum 3 days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

1.7 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Within text of each specifications section, reference may be made to reference standards. Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .2 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.
- .3 Cost for such testing will be borne 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 are to be new, not damaged nor 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 AVAILABILITY

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

1.4 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration, and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials 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 nameplates.

1.5 TRANSPORTATION

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Owner will be paid by Departmental Representative. Unload, handle, and store such products.

1.6 MANUFACTURER'S INSTRUCTIONS

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

1.7 QUALITY OF WORK

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify 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.

1.8 CO-ORDINATION

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

1.9 CONCEALMENT

- .1 In finished areas conceal 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.

1.10 REMEDIAL WORK

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work employing specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.11 LOCATION OF FIXTURES

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

1.12 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.

- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.13 FASTENINGS - EQUIPMENT

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

1.14 PROTECTION OF WORK IN PROGRESS

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

END OF SECTION

Part 1 General

1.1 LOCATION OF EQUIPMENT AND FIXTURES

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Departmental Representative of impending installation and obtain approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

END OF SECTION

Part 1 General

1.1 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than 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, unless approved by Departmental Representative.
- .3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4 Provide on-site containers for collection of waste materials and debris.
- .5 Provide and use marked separate bins for recycling. Refer to Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .6 Dispose of waste materials and debris off site.
- .7 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .8 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .9 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .10 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 When Work is Substantially Performed, remove surplus products, tools, construction machinery, and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris other than that caused by 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, and 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, and behind grilles 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 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .14 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

1.3 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION

Part 1 General

1.1 STORAGE, HANDLING AND PROTECTION

- .1 Materials to be re-used: Store in locations as directed by Departmental Representative.
- .2 Unless specified otherwise, materials for removal become Contractor's property.
- .3 Protect structural components not removed for demolition from movement or damage.
- .4 Support affected structures. If safety of building is endangered, cease operations and immediately notify Departmental Representative.
- .5 Protect surface drainage, mechanical, and electrical from damage and blockage.

1.2 DISPOSAL OF WASTES

- .1 Remove waste materials as Work progresses.
- .2 Do not dispose of waste, volatile materials, mineral spirits, oil, nor paint thinner into waterways, storm, or sanitary sewers.

Part 2 Products

Not used.

Part 3 Execution

3.1 APPLICATION

- .1 Handle waste materials in accordance with appropriate regulations and codes.

3.2 CLEANING

- .1 Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition.
- .2 Clean-up work area as work progresses.

3.3 DIVERSION OF MATERIALS

- .1 On-site sale of salvaged, recovered, reusable, and recyclable material is not permitted.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Acceptance of Work Procedures:
 - .1 Contractor's Inspection:
 - .1 Contractor: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .2 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
 - .3 Request Departmental Representative inspection.
 - .2 Departmental Representative Inspection:
 - .1 Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.
 - .2 Contractor to correct Work as directed.
 - .3 Completion Tasks: submit written certificates, in English, that tasks have been performed as follows:
 - .1 Work: Completed and inspected for compliance with Contract Documents.
 - .2 Defects: Corrected and deficiencies completed.
 - .3 Equipment and systems: Tested, adjusted, balanced, and fully operational.
 - .4 Certificates required by Fire Commissioner, Utility companies: Submitted.
 - .5 Operation of systems: Demonstrated to Owner's personnel.
 - .6 Commissioning of mechanical systems: Completed in accordance with 01 91 13 - General Commissioning (Cx) Requirements and copies of final Commissioning Report submitted to Departmental Representative.
 - .7 Work: Complete and ready for final inspection.
 - .4 Final Inspection:
 - .1 When completion tasks are done, request final inspection of Work by Departmental Representative, and Contractor.
 - .2 When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.

1.2 FINAL CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools, and equipment.

- .2 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-warranty Meeting:
 - .1 Convene meeting one week prior to contract completion with Contractor's Representative and Departmental Representative, in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify Project requirements.
 - .2 Review 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 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, two (2) print and three (3) electronic (on CD or DVD) final copies of operating and maintenance manuals in English. Confirm with Departmental Representative quantities of O&M manuals required.
- .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.
- .9 Provide 1:1 scaled CAD files in .dwg format on CD or DVD.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

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

1.5 AS-BUILT DOCUMENTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.

- .2 Store as-built documents and samples in field office apart from documents used for construction.
 - .1 Provide files, racks, and secure storage.
- .3 Label as-built documents and file in accordance with Section number listings in List of Contents of this Project Manual.
 - .1 Label each document "AS-BUILT DOCUMENTS" in neat, large, printed letters.
- .4 Maintain as-built documents in clean, dry and legible condition.
 - .1 Do not use as-built documents for construction purposes.
- .5 Keep as-built documents and samples available for inspection by Departmental Representative.
- .6 Record as-built information on drawings and in designated copy of Project Manual provided by Departmental Representative.
- .7 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .8 Maintain information during construction on project site drawings and accurately record deviations of newly installed or existing works from Contract documents.
- .9 Use red felt tip marking pens for recording information.
- .10 Mark on one set of prints and at completion of project and prior to final inspection; neatly transfer notations to second set.
- .11 Ensure but do not limit recording of following information on as-built drawings:
 - .1 Locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
 - .2 Changes made by Change Order.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Details not on original Contract Drawings.
 - .6 References to related shop drawings and modifications.
- .12 Incorporate as-built information into CAD drawings.
- .13 Submit as-built drawings to Departmental Representative.
 - .1 Provide in printed hardcopy and electronically in PDF format.
- .14 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.

1.6 EQUIPMENT AND SYSTEMS

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

- .1 Give function, normal operation characteristics, and limiting conditions.
- .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
 - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
 - .2 Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: Include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 91 13 - General Commissioning (Cx) Requirements.
- .15 Additional requirements: as specified in individual specification sections.

1.7 MATERIALS AND FINISHES

- .1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

- .4 Additional requirements: as specified in individual specifications sections.

1.8 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.

1.9 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.

1.10 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 10 month warranty inspection, measured from time of acceptance, by Departmental Representative.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
 - .2 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.
- .3 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.
- .4 Procedure and status of tagging of equipment covered by extended warranties.
- .5 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. Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.11 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.

END OF SECTION

SECTION A - GENERAL INFORMATION

GENERAL INFORMATION

BUILDING NAME: _____ PROJECT NAME: _____

GOC BUILDING NUMBER: _____ PROJECT NUMBER: _____

BUILDING ADDRESS: _____ PROJECT MGR: _____

☐ NEW EQUIPMENT

☐ DECOMMISSIONED EQUIPMENT

☐ REPLACED EQUIPMENT

☐ EQUIPMENT UPDATE

CRITICAL SPARES

☐ TENANT

SECTION B - EQUIPMENT INFORMATION

EQUIPMENT INFORMATION

SYSTEM (PLEASE CHECK THE BOX WHICH APPLIES)

05-Electrical Low Voltage	06-Electric High Voltage	10 - Electrical Auxiliary & Standby Power	15 - Control Monitoring System	20 - Heating	25 - Refrigeration	30 - Ventilation	40-Compress Air, Auxiliary & Process	50-Water Supply	55-Plumbing & Drainage
60 - Fire Protection	65 -Transportation Device	70 - Security	72 - Environmental	75 - Special Purpose	79 - Energy	80-Architectural Structural	85 - Grounds	90-Cafeteria (Excluding Refrigeration)	

BUILDING ITEM CODE ^ V) DESCRIPTION:

CLIENT LOCATION: _____ SPECIFIC LOCATION: _____

FIELD ITEM NUMBER: _____ BUILDING ITEM REPLACES: _____

MANUFACTURER: _____ MODEL NUMBER: _____

SERIAL NUMBER: _____ MODEL NAME: _____

PARENT ITEM#: _____

DATE OF INSTALLATION (YY/MM/DD): _____ PURCHASE PRICE (without GST): _____ PURCHASE DATE (YY/MM/DD): _____

SECTION C - SPECIFIC EQUIPMENT INFORMATION

SPECIFIC EQUIPMENT INFORMATION

ELECTRICAL VOLTS: _____ PHASE: _____ AMPS/FLA: _____ BTU/WATT: _____ HP/WATT: _____

MECHANICAL: C.F.M/G.P.M _____ Capacity _____ Belt Size _____ Quantity _____ Filter Size _____ Quantity _____ Type _____

RATED CAPACITY (kg): _____ REFRIGERANT TYPE: _____ COOLING CAPACITY (TONS): _____

FIRE SUPPRESSION: TYPE: _____ CAPACITY: _____ MANUFACTURER DATE: _____ (yy/mm/dd)

FUEL STORAGE TANK LOCATION: ___ OUTDOOR ABOVEGROUND ___ UNDERGROUND ___ INDOOR UNIT OF MEASURE (litres): _____

ENERGY SOURCE: ___ DIESEL FUEL ___ NATURAL GAS ___ OIL ___ PROPANE ___ ELECTRIC ___ STEAM ___ HOT WATER ___ COLD WATER

ENVIRONMENT DOCUMENTS ATTACHED: YES NO

SECTION D - WARRANTY

WARRANTY

WARRANTOR NAME: _____ WARRANTY START DATE (YY/MM/DD): _____

Maintained during Warranty by: Installer ☐

Parts Warranty Date : _____ (yy/mm/dd)

Maintained during Warranty by: Brookfield GIS ☐

Labour Warranty Date : (yy/mm/dd) _____

COMMENTS

COMMENTS

(yy/mm/dd)

PM SCHEDULING DETAILS

PM SCHEDULING DETAILS

MAINTAINABLE: YES ___ NO ___ ANNUAL NEXT DUE: _____ SERVICE PROVIDER/TECH NAME: _____

SPECIAL INSTRUCTIONS: _____

A) PLEASE SEND COMPLETED FORMS TO YOUR CMMS COORDINATOR FOR PROCESSING

B) PLACE COMPLETED FORM IN PROJECT O&M BINDER IF APPLICABLE

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Demonstrate operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.
- .2 Owner: Provide list of personnel to receive instructions, and co-ordinate their attendance at agreed-upon times.
- .3 Preparation:
 - .1 Verify conditions for demonstration and instructions comply with requirements.
 - .2 Verify designated personnel are present.
 - .3 Ensure equipment has been inspected and put into operation in accordance with Section 01 91 13 – General Commissioning Requirements.
 - .4 Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements, and that 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 equipment location.
 - .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
 - .3 Review contents of manual in detail to explain aspects of operation and maintenance.
 - .4 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.
- .5 Time Allocated for Instructions: Ensure amount of time provided for instruction of each item of equipment or system is adequate for full orientation and training of designated personnel.

1.2 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 personnel 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 designated personnel.
 - .2 Provide written report that demonstration and instructions have been completed.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA Z320-11 (R2016) – Building Commissioning Standard.

1.2 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to functional performance testing of components, equipment, sub-systems, systems, and integrated systems.
- .2 Acronyms:
 - .1 Cx - Commissioning.
 - .2 EMCS - Energy Monitoring and Control Systems.
 - .3 FPT – Functional Performance Testing.
 - .4 O & M - Operation and Maintenance.
 - .5 TAB - Testing, Adjusting, and Balancing.

1.3 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 Functional Performance Testing responsibilities have been completed. Objectives:
 - .1 Verify installed equipment, systems, and integrated systems operate in accordance with contract documents, and design criteria and intent.
 - .2 Effectively train O & M staff.
- .2 Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the Owner's Project Requirements. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the Owner's Project Requirements may be included.
- .3 Owner's Project Requirements: Dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design phases.
- .4 Contractor to appoint internal commissioning representative and assist 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.
- .5 Design Criteria: Client's requirements or determined by Consultant. To meet Project functional and operational requirements.

1.4 COMMISSIONING OVERVIEW

- .1 Section 01 91 31 - Commissioning (Cx) Plan.
- .2 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) Plan.
- .3 Cx 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 that 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 include transfer of critical knowledge to facility operational personnel.
- .6 Design Consultant will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received and reviewed for suitability by Departmental Representative.
 - .2 Equipment, components, systems and integrated systems have been fully commissioned and functional as per design intent within the context of the Owner Requirements.
 - .3 Final O&M and Training Manual received, reviewed and approved by Design Consultant for suitability.
 - .4 Completion of training session to Operation and Maintenance Staff.

1.5 NON-CONFORMANCE TO FUNCTIONAL PERFORMANCE 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 non-functional 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. Costs to be in form of progress payment reductions or hold-back assessments.

1.6 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, and 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.

1.7 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.

1.8 SUBMITTALS

- .1 Submittals: In accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit no later than 8 weeks after award of Contract:
 - .1 Draft Cx documentation.
 - .2 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.

1.9 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 33 - Commissioning (Cx) 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.

1.10 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Chart. Update schedule as necessary during the work to reflect progress on components and systems.
- .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.

1.11 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meetings: Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Chart and as specified.
- .2 Purpose: 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, 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.

1.12 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.

1.13 WITNESSING OF STARTING AND TESTING

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

1.14 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 to witness tests.
 - .4 Confirm review of test results and documentation from Departmental Representative before delivery to site.
- .2 Obtain manufacturers' installation, start-up, and operations instructions and review with Departmental Representative prior to start-up of components, equipment, and systems.
 - .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.

1.15 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 static verification report forms.
 - .2 Visual inspection of quality of installation.
- .2 Start-up: Follow accepted start-up procedures.
- .3 Pre-functional testing: Provide completed FPTs as a pre-functional test prior to formal testing.
- .4 System functional performance testing: Include repetition of tests after correcting deficiencies.
- .5 Post-substantial verification: 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 required tests on approved functional performance testing 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 removed from site and replaced with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.16 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.

1.17 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.

1.18 TEST RESULTS

- .1 If start-up, testing, or functional performance testing produce unacceptable results, repair, replace, or repeat specified startup or functional performance testing procedures until acceptable results are achieved.
- .2 Provide labour and materials, assume costs for re-commissioning including Commissioning Authority's costs.

1.19 START OF COMMISSIONING

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

1.20 INSTRUMENTS / EQUIPMENT

- .1 Submit to Departmental Representative for review:
 - .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.

1.21 COMMISSIONING FUNCTIONAL PERFORMANCE TESTING

- .1 Carry out Cx:
 - .1 Under actual operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable, and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for functional performance testing.

1.22 WITNESSING COMMISSIONING

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

1.23 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.

1.24 COMMISSIONING CONSTRAINTS

- .1 Since access into secure or sensitive areas will be very difficult after occupancy it is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems in these areas before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.25 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.

1.26 EXTENT OF VERIFICATION

- .1 Conduct tests repeated during verification under same conditions as original tests, using same test equipment and instrumentation.
- .2 Review and repeat commissioning of systems if inconsistencies are found in more than 20% of reported results.
- .3 Perform additional commissioning until results are acceptable to Departmental Representative.

1.27 REPEAT VERIFICATIONS

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

1.28 SUNDRY CHECKS AND ADJUSTMENTS

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

1.29 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.

1.30 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.

1.31 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.

1.32 TRAINING

- .1 In accordance with Section 01 91 41 - Commissioning (Cx) - Training.

1.33 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.34 OCCUPANCY

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

1.35 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and functional performance testing 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.

1.36 FUNCTIONAL PERFORMANCE TESTING 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.

1.37 OWNER'S PERFORMANCE TESTING

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

Part 2 Products

Not Used.

Part 3 Execution

Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA Z320-11, Building Commissioning.

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 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 EMCS - Energy Monitoring and Control Systems.

- .3 FPT – Functional Performance Testing.
- .4 MSDS - Material Safety Data Sheets.
- .5 TAB - Testing, Adjusting and Balancing.
- .6 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 by the Departmental Representative and transmitted to the Contractor.
- .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 for review and further obtain Departmental Representative's 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 4 weeks 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 PSPC Design Quality Review Team: During construction, will conduct periodic site reviews to observe general progress.
- .2 PSPC Quality Assurance Commissioning Manager: Confirms Cx processes, forms, and procedures are developed in the Cx Forms by the Departmental Representative to deliver a fully operational project.
- .3 Departmental Representative is responsible for:
 - .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.
- .4 Commissioning Authority is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing accuracy of reported results.
 - .4 Ensuring implementation of final Cx Plan.
 - .5 Performing verification of performance of installed systems and equipment.
 - .6 Implementation of Training Plan.
 - .7 Coordinates and assists Departmental Representative during integrated system verification and testing.
- .5 Construction Team: Contractor, sub-contractors, suppliers, and support disciplines; is responsible for construction/installation in accordance with contract documents, including:
 - .1 TAB.
 - .2 Performance of Cx activities.
 - .3 Delivery of training and Cx documentation.
 - .4 Assigning one person as point of contact with Department Representative and PSPC Cx Manager for administrative and coordination purposes.
 - .5 Revise, refine and update CX plan.
 - .6 Demonstrations.
 - .7 Testing.
- .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 Include functional performance testing.
 - .3 Specialist subcontractor: Equipment and systems supplied and installed by specialist subcontractor.
 - .4 Specialist Testing 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.
 - .1 Include Acoustic Testing Sub-Contractor
 - .5 Contractor's TAB agency:
 - .1 Equipment and systems involving measurement and adjusting of flow rates and pressures to meet indicated or specified values. Includes, but not limited to, ducted air and hydronic systems, fans, pumps, and terminal units.
 - .2 TAB is a construction contractor's activity that permits Designer to certify results of functional performance testing test of installed design to satisfaction of Departmental Representative.
- .2 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.
- .3 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 The following list outlines the extent of Cx.

- .1 Architectural systems:
 - .1 Doors, related hardware:
 - .1 New doors and door hardware.
- .2 Mechanical systems and associated equipment:
 - .1 HVAC and exhaust systems:
 - .1 Transfer Fan
 - .2 Fan Powered Terminal Units
 - .3 Heating/Chilled Water Piping
 - .4 Fin-tube radiation
 - .5 Radiant Panel
 - .6 VAV Revised Flows
 - .7 HVAC TAB
 - .8 Energy Recovery Ventilator (ERV)
 - .9 Split AC Systems
 - .10 Humidifier
 - .2 Fire and life safety systems:
 - .1 Wet pipe sprinkler systems.
 - .2 Fire dampers.
 - .3 Fire extinguishers.
 - .3 EMCS:
 - .1 DDC Controls in project space
 - .2 Thermostats in project space
 - .3 Sensors.
 - .4 Actuators.
- .3 Electrical systems and equipment:
 - .1 Electrical Distribution
 - .1 New distribution panels.
 - .2 Receptacles.
 - .2 Lighting systems:
 - .1 Lighting fixtures and devices.
 - .2 Low-voltage control.
 - .3 Emergency lighting systems, including battery packs.
 - .4 Fire exit emergency signage.
 - .3 Fire alarm systems, equipment:
 - .1 Fire alarm devices.
 - .2 Annunciators.
 - .3 Control panels.
 - .4 Fire alarm battery banks.
 - .4 Emergency (back-up) Power

- .1 Generator
- .2 Transfer Switch
- .3 UPS
- .5 Other systems and equipment:
 - .1 Video surveillance system and devices.
 - .2 Access control system and devices.
 - .3 Paging system and devices.

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 MSDS data sheets.
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.
 - .8 Preventative maintenance program.
 - .9 Contractor's and sub-contractor's 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 functional performance testing.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed static verification forms.

- .4 Completed start-up report forms.
- .5 Completed functional performance testing report forms.
- .6 Results of functional performance testing and Inspections.
- .7 Description of Cx activities and documentation.
- .8 Description of Cx of integrated systems and documentation.
- .9 Tests performed by Departmental Representative.
- .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.
- .6 Commissioning Authority to witness tests.

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 some 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 Conduct pre-functional tests. Complete FPT forms as pre-functional test prior to formal FTPs.
 - .7 Departmental Representative will monitor some of these inspections and tests.
 - .8 Include completed documentation in Cx report.
- .2 Pre-Cx activities – ARCHITECTURAL
 - .1 New door hardware.
 - .1 Confirm function of all door hardware.
- .3 Pre-Cx activities - MECHANICAL:
 - .1 Plumbing systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 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.
 - .2 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 and reviewed by CxA.
 - .3 EMCS:
 - .1 EMCS trending to be available as supporting documentation for functional performance testing.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Demonstrate performance of systems, to be witnessed by Departmental Representative.
 - .4 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
 - .4 Pre-Cx activities - LIFE SAFETY SYSTEMS
 - .1 Sprinkler Systems
 - .1 Testing to include a complete verification in accordance with ULC requirements.
 - .5 Pre-Cx activities - ELECTRICAL:
 - .1 Lighting systems:
 - .1 Emergency lighting systems:
 - .1 Pre-functional tests to include verification of lighting levels and coverage, initially by disrupting normal power.
 - .2 Low voltage lighting control system.
 - .2 Fire alarm systems:
 - .1 Test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements.
 - .3 Other systems: these include:
 - .1 Video surveillance system and devices
 - .2 Access control system and devices
 - .3 Sound masking and paging system.

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 and exhaust systems:
 - .1 Fan Powered Terminal Units
 - .2 ERV
 - .3 Split AC Systems
 - .2 Electrical Systems
 - .1 Emergency power systems
 - .2 Lighting Systems
 - .3 Security/Communication Systems
- .3 Departmental Representative to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Functional Performance Testing:
 - .1 Contractor 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 static verification, start-up, and function performance testing forms.
 - .4 Departmental Representative reserves right to verify up to 30% of reported results at random.
 - .5 Failure of randomly selected item shall result in rejection of functional performance testing report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx using procedures developed and approved by Departmental Representative.
- .2 Departmental Representative to monitor Cx activities.
- .3 Upon satisfactory completion, Commissioning Authority to prepare Cx Report.
- .4 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 Contractor, using procedures developed by Departmental Representative.
- .2 Upon satisfactory completion, Commissioning Authority to prepare Cx Report, to be reviewed by Consultant and submitted to Departmental Representative for review.

- .3 Departmental Representative reserves right to verify percentage of reported results.
- .4 Integrated systems to include:
 - .1 HVAC and associated systems forming part of integrated HVAC systems:
 - .1 Zone ventilation
 - .2 EMCS
 - .2 Fire and life safety systems.
 - .3 Fire alarm systems.
 - .4 Video surveillance system.
 - .5 Access control system.
 - .6 Emergency power systems.
- .5 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance, Departmental Representative, Consultant, Contractor, Project Manager, Property Manager 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 STATIC VERIFICATION/START-UP FORMS

- .1 Refer to Section 01 91 33 – Commissioning (Cx) Forms.

1.16 FUNCTIONAL PERFORMANCE TESTING FORMS

- .1 Refer to Section 01 91 33 – Commissioning (Cx) Forms.

1.17 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.

1.18 CX SCHEDULES

- .1 Prepare detailed critical path 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.
 - .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Department Representative.
 - .3 Include seasonal commissioning in schedule for all seasons of operation.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.

- .3 Contractor, Consultant, and Departmental Representative will monitor progress of Cx against this schedule.

1.19 TEST REPORTS

- .1 Submit reports of tests to Departmental Representative and Consultant.

1.20 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 Seasonal testing.
 - .3 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.

1.21 TRAINING PLANS

- .1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

1.22 FINAL SETTINGS

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

Part 2 Products

Not Used.

Part 3 Execution

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 STATIC VERIFICATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 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 necessary to prepare for start-up and functional performance testing, and used during operation and maintenance of equipment.
 - .2 Product manufacturer's installation instructions and recommended checks.
 - .3 Special procedures as specified in relevant technical sections.
 - .4 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Prior to functional performance testing of systems, complete items on static verification and start-up forms related to systems.
- .3 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Commissioning Authority and Departmental Representative, supplemental additional data lists will be required for specific project conditions.
- .4 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .5 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Commissioning Authority. Check lists will be required during Commissioning and will be included in O & M at completion of project.
- .6 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 FUNCTIONAL PERFORMANCE TESTING FORMS

- .1 Functional performance testing 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 Functional performance testing forms, including those developed by Contractor records measured data and readings taken during functional testing and functional performance testing procedures.
- .3 Prior to functional performance testing of integrated system, complete functional performance testing forms of related systems and obtain Departmental Representative's approval.

1.4 SAMPLES OF COMMISSIONING FORMS

- .1 Commissioning Authority will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
- .2 Commissioning forms are attached to this section.
 - .1 Forms are subject to modifications upon receipt of approved shop drawings.
 - .2 Forms may be developed and provided during construction, depending on the system.

1.5 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Commissioning Authority, 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 Commissioning Authority.
- .2 Additional forms and tests may be provided as submittal documentation is received and finalized.

1.6 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Commissioning Authority 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 to 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.

- .9 Submit immediately after tests are performed.
- .10 Report results in true measured SI unit values.
- .11 Provide Commissioning Authority with originals of completed forms.
- .12 Maintain copy on site during start-up, testing, and commissioning period.

1.7 LANGUAGE

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

Part 2 Products

Not Used.

Part 3 Execution

Not Used.

END OF SECTION

SECTION A - GENERAL INFORMATION

GENERAL INFORMATION

BUILDING NAME: _____ PROJECT NAME: _____

GOC BUILDING NUMBER: _____ PROJECT NUMBER: _____

BUILDING ADDRESS: _____ PROJECT MGR: _____

☐ NEW EQUIPMENT

☐ DECOMMISSIONED EQUIPMENT

☐ REPLACED EQUIPMENT

☐ EQUIPMENT UPDATE

CRITICAL SPARES

☐ TENANT

SECTION B - EQUIPMENT INFORMATION

EQUIPMENT INFORMATION

SYSTEM (PLEASE CHECK THE BOX WHICH APPLIES)

05-Electrical Low Voltage	06-Electrical High Voltage	10 - Electrical Auxiliary & Standby Power	15 - Control Monitoring System	20 - Heating	25 - Refrigeration	30 - Ventilation	40-Compress Air, Auxiliary & Process	50-Water Supply	55-Plumbing & Drainage
60 - Fire Protection	65 -Transportation Device	70 - Security	72 - Environmental	75 - Special Purpose	79 - Energy	80-Architectural Structural	85 - Grounds	90-Cafeteria (Excluding Refrigeration)	

BUILDING ITEM CODE ^ V) DESCRIPTION:

CLIENT LOCATION: _____ SPECIFIC LOCATION: _____

FIELD ITEM NUMBER: _____ BUILDING ITEM REPLACES: _____

MANUFACTURER: _____ MODEL NUMBER: _____

SERIAL NUMBER: _____ MODEL NAME: _____

PARENT ITEM#: _____

DATE OF INSTALLATION (YY/MM/DD): _____ PURCHASE PRICE (without GST): _____ PURCHASE DATE (YY/MM/DD): _____

SECTION C - SPECIFIC EQUIPMENT INFORMATION

SPECIFIC EQUIPMENT INFORMATION

ELECTRICAL VOLTS: _____ PHASE: _____ AMPS/FLA: _____ BTU/WATT: _____ HP/WATT: _____

MECHANICAL: C.F.M/G.P.M _____ Capacity _____ Belt Size _____ Quantity _____ Filter Size _____ Quantity _____ Type _____

RATED CAPACITY (kg): _____ REFRIGERANT TYPE: _____ COOLING CAPACITY (TONS): _____

FIRE SUPPRESSION: TYPE: _____ CAPACITY: _____ MANUFACTURER DATE: _____ (yy/mm/dd)

FUEL STORAGE TANK LOCATION: ___ OUTDOOR ABOVEGROUND ___ UNDERGROUND ___ INDOOR UNIT OF MEASURE (litres): _____

ENERGY SOURCE: ___ DIESEL FUEL ___ NATURAL GAS ___ OIL ___ PROPANE ___ ELECTRIC ___ STEAM ___ HOT WATER ___ COLD WATER

ENVIRONMENT DOCUMENTS ATTACHED: YES NO

SECTION D - WARRANTY

WARRANTY

WARRANTOR NAME: _____ WARRANTY START DATE (YY/MM/DD): _____

Maintained during Warranty by: Installer ☐

Parts Warranty Date : _____ (yy/mm/dd)

Maintained during Warranty by: Brookfield GIS ☐

Labour Warranty Date : (yy/mm/dd) _____

COMMENTS

COMMENTS

(yy/mm/dd)

PM SCHEDULING DETAILS

PM SCHEDULING DETAILS

MAINTAINABLE: YES ___ NO ___ ANNUAL NEXT DUE: _____ SERVICE PROVIDER/TECH NAME: _____

SPECIAL INSTRUCTIONS: _____

A) PLEASE SEND COMPLETED FORMS TO YOUR CMMS COORDINATOR FOR PROCESSING

B) PLACE COMPLETED FORM IN PROJECT O&M BINDER IF APPLICABLE

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **AC-1**
Equipment Type: Fan Coil Unit
System: HVAC
Location: Rm 480
Area Serviced: Rm 479B

This box for IDI use only.

CxA reviewer: _____

Form Auditted?

YES ☐

NO ☐

Contractor (include company and print name)

Signature

Date

Mechanical:

Electrical:

Controls:

General:

IDI Audit Verification

Nameplate Data

Submitted

Installed
note any changes

Installer
Verify

Manufacturer

Mitsubishi

☐

Model

PEAD-A42AA7

☐

Airflow [cfm]

1483

☐

Fan Power [W]

74

☐

Electrical [V/Ph/Hz]

☐

Details/Notes:

Inspection Items

Comments

Installer
Verify

General Installation & Cleanliness

Equipment is clean and free of debris

☐

Equipment is properly mounted and vibration isolation equipment is installed.

☐

Service hatches & filter access is not hindered by surrounding equipment

☐

Thermal Insulation complete as per contract documents

☐

Unit is correctly labelled

☐

Duct Installation

Duct layout matches drawings and duct connections are sealed

☐

Smoke and fire dampers are properly installed according to contract documents

☐

Piping Installation

Condensate drain installed including P-trap and drain line slopes away from unit

☐

Electrical Installation

Wiring complete and electrical connections are tight

☐

Local disconnects are installed and labelled

☐

Controls Installation

Controls wiring complete and electrical connections are tight

☐

Control actuators and sensors labelled per contract documents

☐

Thermostat is located away from external temperature influences

☐

Thermostat is correctly labelled

☐

PI/PV Checksheets

Unit Tag: **CU-1**
Equipment Type: Condensing Unit
System: HVAC
Location: Roof
Area Served: AC-1

IDI Audit Verification

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **VAV-1**
Equipment Type: Variable Air Volume Unit
System: HVAC
Location: Rm 481
Area Serviced: Rm 481, Rm 480

This box for IDI use only.

CxA reviewer: _____

Form Auditted?

YES ☐

NO ☐

Contractor (include company and print name)

Signature

Date

Mechanical:

Electrical:

Controls:

General:

IDI Audit Verification

Nameplate Data

Submitted

Installed
note any changes

Installer
Verify

Manufacturer

☐

Model

☐

Airflow [cfm]

max: 513, min: 204

☐

Details/Notes:

Inspection Items

Comments

Installer
Verify

General Installation & Cleanliness

Equipment is clean and free of debris

☐

Equipment is securely mounted and level.

☐

Service hatches & filter access is not hindered by surrounding equipment

☐

Unit is correctly labelled

☐

Duct Installation

Duct layout matches drawings and duct connections are sealed

☐

Electrical Installation

Wiring complete and electrical connections are tight

☐

Controls Installation

Controls wiring complete and electrical connections are tight

☐

Control actuators and sensors labelled per contract documents

☐

Thermostat is located away from external temperature influences

☐

Thermostat is correctly labelled

☐

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **WF-1**
Equipment Type: Wallfin Convection
System: HVAC
Location: Rm 479A
Area Serviced: Rm 479A

This box for IDI use only.

CxA reviewer: _____

Form Auditted? YES ☐
NO ☐

Contractor (include company and print name)	Signature	Date
Mechanical:		
Electrical:		
Controls:		
General:		

IDI Audit Verification

Nameplate Data	Submitted	Installed <i>note any changes</i>	Installer Verify
Manufacturer	Rosemex		<input type="checkbox"/>
Model	RVT		<input type="checkbox"/>
Length [m]	5		<input type="checkbox"/>
Water Flow Rate [GPM]	2.1		<input type="checkbox"/>
Details/Notes:			

Inspection Items	Comments	Installer Verify
General Installation & Cleanliness		
Equipment is accessible for service and maintenance		<input type="checkbox"/>
Equipment is properly supported and level		<input type="checkbox"/>
Equipment is clean and free of debris		<input type="checkbox"/>
Piping Installation		
Piping is properly supported independently of the unit		<input type="checkbox"/>
Piping layout matches drawings and associated components are installed.		<input type="checkbox"/>
Insulation & Labelling		
Thermal Insulation complete as per contract documents		<input type="checkbox"/>
Pipe labeling is complete and direction of flow is indicated		<input type="checkbox"/>
Equipment is labelled		<input type="checkbox"/>

IDI Audit Verification

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **TF-1**
Equipment Type: Transfer Fan
System: HVAC
Location: Rm 482
Area Serviced: Rm 482

This box for IDI use only.

CxA reviewer: _____

Form Auditted? YES ☐
NO ☐

Contractor (include company and print name)	Signature	Date
Mechanical:		
Electrical:		
Controls:		
General:		

IDI Audit Verification

Nameplate Data	Submitted	Installed <i>note any changes</i>	Installer Verify
Manufacturer	Greenheck		<input type="checkbox"/>
Model	CSP-A290		<input type="checkbox"/>
Airflow [cfm]	300		<input type="checkbox"/>
Fan Power [W]	98		<input type="checkbox"/>
Electrical [V/Ph/Hz]			<input type="checkbox"/>
Details/Notes: c/w speed controller, spring hangers, disconnect switch			

Inspection Items	Comments	Installer Verify
General Installation & Cleanliness		
Equipment is clean and free of debris		<input type="checkbox"/>
Equipment is properly mounted and vibration isolation equipment is installed		<input type="checkbox"/>
Equipment is accessible for service and maintenance		<input type="checkbox"/>
Equipment is labelled		<input type="checkbox"/>
Duct Installation		
Duct layout matches drawings, duct are securely mounted and connections are sealed		<input type="checkbox"/>
Motorized dampers or back draft dampers are installed		<input type="checkbox"/>
Electrical Installation		
Wiring complete and electrical connections are tight		<input type="checkbox"/>
Local disconnects are installed and labelled		<input type="checkbox"/>
Controls Installation		
Controls wiring complete and electrical connections are tight		<input type="checkbox"/>
Control actuators and sensors labelled per contract documents		<input type="checkbox"/>

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **H-1**
Equipment Type: Humidifier
System: HVAC
Location: Rm 480
Area Serviced: Call Centre

This box for IDI use only.

CxA reviewer: _____

Form Auditted? YES ☐
NO ☐

Contractor (include company and print name)

Signature

Date

Mechanical: _____

Electrical: _____

Controls: _____

General: _____

IDI Audit Verification

Nameplate Data

Submitted

Installed
note any changes

Installer
Verify

Manufacturer

☐

Model

☐

Maximum Power [kW]

1.9

☐

Electrical [V/Ph/Hz]

☐

Details/Notes:

Inspection Items

Comments

Installer
Verify

General Installation & Cleanliness

Equipment is accessible for service and maintenance

☐

Equipment is properly supported and level

☐

Equipment is clean and free of debris

☐

Piping Installation

Piping is properly supported independently of the pump

☐

Piping layout matches drawings and associated components (isolation valves, thermostats, pressure gauges, drains, heat traps) are installed.

☐

Drain line is trapped and piped to drain (both dispersion panel and supply piping)

☐

Electrical Installation

Wiring complete and electrical connections are tight

☐

Local disconnect is installed and labelled

☐

Insulation & Labelling

Thermal Insulation complete as per contract documents

☐

Pipe labeling is complete and direction of flow is indicated

☐

Equipment is labelled

☐

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **RP-1**
Equipment Type: Radiant Panel
System: HVAC
Location: Rm 480
Area Serviced: Rm 480

This box for IDI use only.

CxA reviewer: _____

Form Auditted? YES ☐
NO ☐

Contractor (include company and print name)

Signature

Date

Mechanical:

Electrical:

Controls:

General:

IDI Audit Verification

Nameplate Data

Submitted

Installed
note any changes

Installer
Verify

Manufacturer

Model

HEF-2

Water Flow Rate [GPM]

1.01

Details/Notes:

Inspection Items

Comments

Installer
Verify

General Installation & Cleanliness

Equipment is accessible for service and maintenance

Equipment is securely hung

Equipment is clean and free of debris

Piping Installation

Piping is properly supported independently of the panel

Piping layout matches drawings

Associated components such as isolation valves are installed

Insulation & Labelling

Thermal Insulation complete as per contract documents

Pipe labeling is complete and direction of flow is indicated

Controls Installation

Controls wiring complete and electrical connections are tight

Thermostat is located away from external temperature influences

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **ERV-1**
Equipment Type: Energy Recovery Ventilation
System: HVAC
Location: Rm 476C
Area Serviced: Call Centre Fan coils

This box for IDI use only.

CxA reviewer: _____

Form Auditted?

YES ☐

NO ☐

Contractor (include company and print name)

Signature

Date

Mechanical: _____

Electrical: _____

Controls: _____

General: _____

IDI Audit Verification

Nameplate Data

Submitted

Installed
note any changes

Installer
Verify

Manufacturer

Greenheck

☐

Model

ECV-10-VG

☐

Supply Fan [HP]

1/2

☐

Return Fan [HP]

1/2

☐

Details/Notes:

c/w pre-heating coil and post-heating coil

Inspection Items

Comments

Installer
Verify

General Installation & Cleanliness

Equipment is properly supported and vibration isolation equipment is installed

☐

Equipment is accessible for service and maintenance

☐

Equipment is clean and free of debris

☐

Shipping mounts are removed

☐

Equipment is labelled

☐

Electrical Installation

Wiring complete and electrical connections are tight

☐

Local disconnect is installed and labelled

☐

Controls Installation

Controls wiring complete and electrical connections are tight

☐

Control actuators and sensors labelled per contract documents

☐

Ducting & Insulation

Thermal Insulation on ducts complete as per contract documents

☐

Duct layout matches drawings and duct connections are sealed

☐

Interior Alterations

PI/PV Checksheets

1091 Portage Avenue
Winnipeg, Manitoba

Unit Tag: **23-U1-A**
Equipment Type: Panelboard
System: Electrical Distribution
Location:
Area Serviced:

This box for IDI use only.

CxA reviewer: _____

Form Auditted?

YES ☐

NO ☐

Contractor (include company and print name)

Signature

Date

Mechanical:

Electrical:

Controls:

General:

IDI Audit Verification

Nameplate Data

Submitted

Installed
note any changes

Installer
Verify

Manufacturer

Model

Fed From

Main Breaker

225A

Electrical

120/208V/3Ph/4W

Number of Circuits

72

Details/Notes:

Surface moutned

Inspection Items

Comments

Installer
Verify

General Panel Installation

Panel is installed in the correct location

Panel is mounted securely.

Panel is accessible for service and maintenance.

Panel is clean and free of debris

Panel is labelled as per contract documents

Circuits Installation and Labelling

Unused breaker slots are closed off

Unused conduit openings are closed off

Panel directory is complete, legible and mounted in panelboard.

Interior Alterations

1091 Portage Avenue
Winnipeg, Manitoba

Functional Performance Testing

Zone Control - VAV Terminal Units

Zone Control - VAV Terminal Units

System Components:

VAV terminal units, BMS, fin-tube radiation heating

System Description:

This test is applicable to the VAV zone control terminal units and the auxiliary heating for the zone (perimeter radiation). Record the VAV number and the applicable heating devices.

Testing Notes:

Record VAV number: _____

Record VAV location: _____

Perimeter radiation? YES / NO

	Test and Expectation	Test Notes	Sign-Off
001	VAV Normal Operation		
002	Occupancy Schedule and Setbacks The EMCS modulates the VAV damper and auxiliary heating (of applicable) to maintain space temperature setpoint during occupied and unoccupied periods. Verify with trends.	Record occupancy schedule: Record occupied space temperature setpoint: Record unoccupied space temperature setpoint:	Date: Initials:
003	Unoccupied mode override. The zone can manually switched to occupied mode for a period of time using a override button on thermostat. Verify by operational check.		Date: Initials:
007	Occupied Mode The VAV damper modulates to maintain space temperature setpoint. Verify by operational check for: - Call for heating - Call for cooling		Date: Initials:
008	Unoccupied Mode During unoccupied mode, the VAV damper is modulated to maintain night space temperature setpoint. Verify with operational check.		Date: Initials:
001	Graphics and Alarms		
004	Graphics & Trends Graphics to include at least: - space temperature - temperature setpoint - VAV damper command - auxiliary heating command All points to be trended.		Date: Initials:
006	Alarms EMCs to generate an alarm if space temperature exceeds acceptable differential from temperature setpoint. Verify by operational check.		Date: Initials:
008	Operation Meets Generally Accepted Good Practice Record any discrepancies notes in installation or operation of the equipment.		Date: Initials:

Interior Alterations

Door Control/Door Hardware Identification, Verification and Testing

1091 Portage Avenue
Winnipeg, Manitoba

			PI / PV				Functional Performance Tests						Sign-off	Comments
Room Tag	Room #	Door #	Record Hardware Type	Record Access Control Device Type (where applicable)	Verify device location and type matches reviewed shop drawings and/or contract documents.	Verify hardware and control devices are clean and free of damage.	Perform operational test of each subsystem to verify equipment is properly connected, interfaced and functionally operational.	Check each door utilizing a meter to confirm each card reader function.	Verify sensitivity of readers and application of cards.	Verify Card reader pad operates as required. Confirm function via authorized and non authorized access cards.	Verify panic bar operation and associated alarm	Operation meets generally accepted good practice	Record date verification and testing completed.	Record any additional information or observation noted during verification and testing.
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	

Interior Alterations

Lighting Identification, Verification and Testing

1091 Portage Avenue
Winnipeg, Manitoba

		PI / PV					Functional Performance Tests						Sign-off	Comments
Room Tag	Room #	Record Fixture Type, Lamp Type, and Counts	Record Control Device Type and Counts	Record Emergency Lights and Exit Signs Type and Counts	Verify Electrical Installation Complete and Control Device Circuit is Labelled	Verify fixtures and control devices are clean and free of damage.	Verify Lighting Operates when switched ON	Verify Lighting operates on Occupancy Sensor if applicable	Verify Nightlighting operates according to construction drawings.	Verify Lighting Control conforms to plan.	No unacceptable noise or flickering	Operation meets generally accepted good practice	Record date verification and testing completed.	Record any additional information or observation noted during verification and testing.
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	
													Date: Initials:	

Interior Alterations

Public Address System Identification, Verification and Testing

1091 Portage Avenue
Winnipeg, Manitoba

		PI / PV			Functional Performance Tests					Sign-off	Comments
Room Tag	Room #	Record Device Types & Count	Verify device location and type matches reviewed shop drawings and/or contract documents.	Verify hardware and devices are clean and free of damage.	Perform operational test of each subsystem to verify equipment is properly connected, interfaced and functionally operational.	Verify calibration and setup of all input and output devices.	Verify paging function for all devices in all zones. Verify sound masking system returns to normal operation following paging.	Verify correct annunciation back to central system.	Operation meets generally accepted good practice	Record date verification and testing completed.	Record any additional information or observation noted during verification and testing.
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	

Interior Alterations

Receptacles Identification, Verification and Testing

1091 Portage Avenue
Winnipeg, Manitoba

		PI / PV			Functional Performance Tests					Sign-off	Comments
Room Tag	Room #	Record Receptacle Type (duplex, GFCI, etc.), Counts, and Circuit ID	Verify Electrical Installation Complete and Circuit is Labelled	Verify receptacles are clean and free of damage.	Verify voltage is within allowable range	Verify Ground Fault Function (where applicable)	Confirm wiring is correct through receptacle tester.	Verify breaker correctly disconnects power at receptacle	Operation meets generally accepted good practice	Record date verification and testing completed.	Record any additional information or observation noted during verification and testing.
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	
										Date: Initials:	

Interior Alterations

Video Surveillance Identification, Verification and Testing

1091 Portage Avenue
Winnipeg, Manitoba

		PI / PV		Functional Performance Tests				Sign-off	Comments
Room Tag	Room #	Verify device location and type matches reviewed shop drawings and/or contract documents.	Verify hardware and devices are clean and free of damage.	Perform operational test of each subsystem to verify equipment is properly connected, interfaced and functionally operational.	Verify sensitivity and aiming of cameras	Verify integration with central monitoring equipment (monitors, etc.)	Operation meets generally accepted good practice	Record date verification and testing completed.	Record any additional information or observation noted during verification and testing.
								Date: Initials:	
								Date: Initials:	
								Date: Initials:	
								Date: Initials:	
								Date: Initials:	
								Date: Initials:	

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

- .1 Trainees: Personnel selected for operating and maintaining facility; includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

- .1 Consultant will provide:
 - .1 Descriptions of systems.
 - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
 - .1 Start-up, operation, shut-down of equipment, components and systems.
 - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
 - .3 Instructions on servicing, maintenance, and adjustment of systems, equipment, and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
 - .1 Start-up, operation, maintenance, and shut-down of equipment they have certified installation, started up and carried out functional performance tests.

1.4 TRAINING OBJECTIVES

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

1.5 TRAINING MATERIALS

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
 - .1 "As-Built" Contract Documents.
 - .2 O&M Manuals.
 - .3 TAB and Functional Performance Testing Reports.
- .3 Project Manager, Commissioning Manager, and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Multimedia presentations.
 - .2 Manufacturer's training videos.
 - .3 Equipment models.

1.6 SCHEDULING

- .1 Include in Commissioning Schedule time for training.
- .2 Deliver training during regular working hours, training sessions to be 3 hours in length.
- .3 Training to be completed prior to acceptance of facility.

1.7 RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Departmental Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative.
 - .1 Use attached Owner Training Plan and Training Verification Form to document training.

1.8 TRAINING CONTENT

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
 - .1 Review of facility and occupancy profile.
 - .2 Functional requirements.

- .3 System philosophy, limitations of systems and emergency procedures.
- .4 Review of system layout, equipment, components and controls.
- .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
- .7 Maintenance and servicing.
- .8 Trouble-shooting diagnosis.
- .9 Interaction among systems during integrated operation.
- .10 Review of O & M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

1.9 VIDEO-BASED TRAINING

- .1 Manufacturer's videotapes to be used as training tool with Departmental Representative's review and written approval 3 months prior to commencement of scheduled training.
- .2 On-Site training videos:
 - .1 Videotape training sessions for use during future training.
 - .2 To be performed after systems are fully commissioned.
 - .3 Organize into several short modules to permit incorporation of changes.
- .3 Production methods to be professional and high quality.

Part 2 Products
Not Used.

Part 3 Execution
Not Used.

END OF SECTION

Owner Training Plan

Interior Alterations

1091 Portage Avenue
Winnipeg

The contractor is responsible for training of O & M staff to ensure they have all information necessary to operate and maintain commissioned features and systems. The contractor shall submit a training plan and schedule to CxA for review and shall cover the following equipment (at a minimum).

Equipment/System	Contractor/Supplier Providing Training	Owner/Operator Attendees	Training Duration	Date of Training

The training plan for each component or system will address the following topics, if applicable. Additional topics may be required at the discretion of the Contractor or Owner.

- Review of facility and occupancy profile.
- Functional requirements.
- System philosophy, limitations of systems and emergency procedures.
- Review of system layout, equipment, components and controls.
- Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.

- System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
- Maintenance and servicing.
- Trouble-shooting diagnosis.
- Interaction among systems during integrated operation.
- Review of O & M documentation.

During the training session the following materials shall be available for referencing and review.

- "As-Built" Contract Documents
- Maintenance Manuals
- Special Tools
- Suggested Maintenance Schedule and routines

Training verification forms (attached) shall be completed during the training sessions and submitted to CxA for review.

Training Verification Form

Interior Alterations

1091 Portage Avenue
Winnipeg

Date:

Name:

Equipment:

Training Covered:

1. Was the Instructor familiar with the equipment?

Yes ☐ No ☐

2. Was the topic covered completely?

Yes ☐ No ☐

3. Were your questions answered?
(if No, list questions?)

Yes ☐ No ☐

4. Overall, are you satisfied?

Yes ☐ No ☐

Comments

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 This section is limited to portions of the Systems Operation Manual (SOM) provided to Departmental Representative by Contractor.
- .2 Acronyms:
 - .1 Cx - Commissioning.
 - .2 FPT - Functional Performance Testing.
 - .3 HVAC - Heating, Ventilation and Air Conditioning.
 - .4 SOM – Systems Operation Manual.
 - .5 TAB - Testing, Adjusting, and Balancing.
 - .6 WHMIS - Workplace Hazardous Materials Information System.

1.2 GENERAL REQUIREMENTS

- .1 Standard letter size paper 216 mm x 279 mm.
- .2 Methodology used to facilitate updating.
- .3 Drawings, diagrams and schematics to be professionally developed.
- .4 Electronic copy of data to be in a format accepted and approved by Departmental Representative.

1.3 APPROVALS

- .1 Prior to commencement, co-ordinate requirements for preparation, submission and approval with Departmental Representative.

1.4 GENERAL INFORMATION

- .1 Provide Departmental Representative the following for insertion into appropriate Part and Section of SOM:
 - .1 Complete list of names, addresses, telephone and fax numbers of contractor, sub-contractors that participated in delivery of project - as indicated in Section 1.2 of SOM.
 - .2 Summary of architectural, structural, fire protection, mechanical, and electrical systems installed and commissioned - as indicated in Section 1.4 of SOM.
 - .1 Include sequence of operation as finalized after commissioning is complete as indicated in Section 2.0 of SOM.
 - .3 Description of building operation under conditions of heightened security and emergencies as indicated in Section 2.0 of SOM.
 - .4 System, equipment, and components Maintenance Management System (MMS) identification - Section 2.1 of SOM.

- .5 Information on operation and maintenance of architectural systems and equipment installed and commissioned - Section 2.0 of SOM.
- .6 Information on operation and maintenance of fire protection and life safety systems and equipment installed and commissioned - Section 2.0 of SOM.
- .7 Information on operation and maintenance of mechanical systems and equipment installed and commissioned - Section 2.0 of SOM.
- .8 Operating and maintenance manual - Section 3.2 of SOM.
- .9 Final commissioning plan as actually implemented.
- .10 Completed commissioning checklists.
- .11 Commissioning test procedures employed.
- .12 Completed Static Verification (SV) and Functional Performance Testing (FPT) report forms, reviewed by Departmental Representative.
- .13 Commissioning reports.

1.5 CONTENTS OF OPERATING AND MAINTENANCE MANUAL

- .1 Departmental Representative to review and approve format and organization within 6 weeks of award of contract.
- .2 Include original manufacturers' brochures and written information on products and equipment installed on this project.
- .3 Record and organize for easy access and retrieval of information contained in SOM.
- .4 Include completed static verification report forms, data, and information from other sources as required.
- .5 Inventory directory relating to information on installed systems, equipment and components.
- .6 Approved project shop-drawings, product, and maintenance data.
- .7 Manufacturers' data and recommendations relating manufacturing process, installation, commissioning, start-up, O & M, shutdown, and training materials.
- .8 Inventory and location of spare parts, special tools, and maintenance materials.
- .9 Warranty information.
- .10 Inspection certificates with expiration dates, that require on-going re-certification inspections.
- .11 Maintenance program supporting information including:
 - .1 Recommended maintenance procedures and schedule.
 - .2 Information to removal and replacement of equipment including, required equipment, points of lift, and means of entry and egress.

1.6 LIFE SAFETY COMPLIANCE (LSC) MANUAL

- .1 Samples of LSC Manual will be available from Departmental Representative.

- .2 Content of Manual:
 - .1 All possible Emergency situations modes including: Presence of fire and smoke, power failure, lose of water or pressure, chemical spills, and refrigerant release.
 - .2 HVAC emergencies and fuel supply failures.
 - .3 Intrusion and security breach.
 - .4 Emergency provisions for natural disasters, bomb threats, and other disruptive situations.
 - .5 Dedicated emergency generators.
 - .6 Emergency control procedures for fire, power, and major equipment failure.
 - .7 Emergency contacts and numbers.
 - .8 Manual to be readily available and comprehensible to non-technical readers.

1.7 SUPPORTING DOCUMENTATION FOR INSERTION INTO SUPPORTING APPENDICES

- .1 Provide Departmental Representative with supporting documentation relating to installed equipment and system, including:
 - .1 General:
 - .1 Finalized commissioning plan.
 - .2 WHMIS information manual.
 - .3 Approved record drawings and specifications.
 - .4 Procedures used during commissioning.
 - .5 Cross-reference to specification sections.
 - .2 Architectural and structural:
 - .1 Inspection certificates, construction permits.
 - .2 FPT reports.
 - .3 Mechanical:
 - .1 Installation permits, inspection certificates.
 - .2 FPT reports.
 - .3 Copies of posted instructions.
 - .4 Electrical:
 - .1 Installation permits, inspection certificates.
 - .2 FPT reports.
 - .3 Electrical work log book.
 - .4 Charts and schedules.
 - .5 Locations of cables and components.
 - .6 Copies of posted instructions.
- .2 Assist Departmental Representative with preparation of SOM.

1.8 LANGUAGE

- .1 English will be used for the Manual.

1.9 USE OF CURRENT TECHNOLOGY

- .1 Use current technology for production of documentation. Emphasis on ease of accessibility at all times, maintain in up-to-date state, compatibility with user's requirements.
- .2 Obtain Departmental Representative's approval before starting Work.

Part 2 Products

- .1 Not used.

Part 3 Execution

- .1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit 20 Days prior to start of demolition and removals Work.
- .3 Where required, submissions to be signed and sealed by a Professional Engineer licensed in the Province of Manitoba.
- .4 Shop Drawings
 - .1 Drawings, diagrams or details indicating sequence of disassembly Work and supporting structure.
 - .2 Plan showing impacts, interruptions, and delays to building operations.

1.3 SITE CONDITIONS

- .1 Perform operations, machine and equipment movements, deliveries and removals at time or times that will permit uninterrupted operations in and around structures, including parking, deliveries, and Site access and egress.
- .2 Take over structures to be demolished based on condition on date that Bids close.

Part 2 Products

Not used.

Part 3 Execution

3.1 GENERAL

- .1 Products requiring demolition become Contractor's property. Remove Products from Site daily, unless such Products are otherwise specified or indicated on Contract Drawings to be reused or handed over to Departmental Representative.
- .2 Stockpiling of rubble, debris and surplus Products on Site will not be permitted.
- .3 Clean up rubble and debris resulting from Work promptly and dispose at end of day or place in waste disposal bins. Empty bins on regular basis.

3.2 EXAMINATION

- .1 Examine adjacent structures and other installations prior to commencement of demolition and removals Work.

3.3 PROTECTION

- .1 Prevent movement of or damage to adjacent structures, services and parts of existing structure to remain. Supply and install bracing and shoring as required. Make good damage caused by demolition, to acceptance of Departmental Representative.
- .2 Protect adjacent structures and property against damage that might occur from falling debris or other causes. Repair or replace damage caused from Work of this Section, to acceptance of Departmental Representative.
- .3 Do not interfere with use of adjacent structures and Work areas. Maintain free and safe passage to and from adjacent structures and Work areas.
- .4 Take precautions to support affected structures. If safety of structure being demolished, adjacent structures or services are endangered, cease demolition operations and take necessary action to support endangered item. Immediately inform Departmental Representative. Do not resume demolition until reasons for endangering have been determined and corrected and action taken to prevent further endangering.
- .5 If movement or settlement occurs, install additional bracing and shoring as necessary and make good any damage to acceptance of Departmental Representative.
- .6 Prevent debris from blocking surface drainage system, and mechanical and electrical systems which are required to remain in operation.
- .7 Pay particular attention to prevention of fire and elimination of fire hazards that would endanger Work or adjacent structures and premises.
- .8 Close off access to areas where demolition is proceeding, using barricades and post warning signs.
- .9 Where required, supply, install and maintain barricades, guards, railings, lights, warning signs, security and other safety measures, and fully protect persons and property.
- .10 Dust/Weather Protection:
 - .1 Prior to demolition Work proceeding in existing structures, temporarily enclose Work areas, access and supply and install dustproof partitions. Design partitions to prevent dust and dirt infiltration into adjoining areas.
 - .2 Prevent dust, dirt and material caused by demolition operations from entering operational areas.
 - .3 Adjust and relocate partitions as required for various operations of Work.
 - .4 Upon completion of Work, remove and dispose of partitions from Site.

3.4 PREPARATION

- .1 Disconnect and/or reroute electrical data, communication and telephone service lines entering structures to be demolished. Remove abandoned lines as indicated on Contract Drawings.
- .2 Post warning signs on electrical lines and equipment that is required to remain energized.

3.5 DEMOLITION

- .1 Perform demolition with extreme care. Confine effects of demolition to those parts that are to be demolished.
- .2 Perform Work and prevent inconvenience to User Department personnel outside the demolition area.
- .3 Carry out demolition in accordance with the requirements of CSA S350.
- .4 Perform Work to minimize dust.
- .5 Do not sell nor burn materials on Site.
- .6 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as Work progresses.
- .7 At end of day's Work, leave Work in safe condition with no part in danger of toppling or falling.
- .8 Drainage and Sewer System Protection:
 - .1 Ensure that no dust, debris, nor slurry enter drainage and sewer system on Site.
 - .2 Remove and dispose of debris and slurry promptly from Site.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in length at 99.97% efficiency.
- .2 Amended water: Water with a non-ionic surfactant wetting agent added to reduce water tension to allow thorough wetting of fibres.
- .3 Non-Friable Material: Material that when dry cannot be crumbled, pulverized, or powered by hand pressure. Includes, but is not limited to, the following asbestos containing products: vinyl asbestos floor tiles, resilient sheet flooring, acoustic ceiling and wall tiles, gaskets, seals, light heat shields, packing, friction products, drywall joint compounds and asbestos cement boards (transite sheets), shingles and piping.
- .4 Authorized Visitor(s): Departmental Representative, Consultant, or persons representing regulatory agencies, and persons authorized by them.

1.2 REGULATORY AGENCIES

- .1 Comply with Federal, Provincial, and local requirements pertaining to asbestos. In case of conflict among these requirements or with these specifications, the more stringent requirement is to apply. Perform work under regulations in effect at the time work is performed.
- .2 Comply with:
 - .1 Manitoba Workplace Safety and Health Act (W210).
 - .2 Manitoba Workplace Safety and Health Regulation (MR 217/2006).
 - .3 Safe Work Manitoba "Guide for Asbestos Management," dated June 2016.
 - .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-03, Sealer for Application of Asbestos Fibre Releasing Materials.
 - .5 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
 - .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
 - .8 Policies and procedures of the Building Operations Management. All material handling and associated equipment must conform to and be

operated in accordance with "Work Place Materials Information System" (WHIMIS).

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit proof satisfactory to the Departmental Representative that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction. Provide Bill of Lading to Departmental Representative.
- .3 Submit to Departmental Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.

1.4 EXISTING CONDITIONS

- .1 Notify Departmental Representative of similar material discovered during the work and not apparent from the drawings, specifications, or report, pertaining to the work. Do not disturb such material, pending instructions from the Departmental Representative.

1.5 INSTRUCTION AND TRAINING

- .1 Before commencing the work, provide to the Departmental Representative:
 - .1 Satisfactory proof that every worker has had instruction and training in the hazards of asbestos exposure, in personal hygiene and work practices, and in the use, cleaning, and disposal of respirators and protective clothing.
- .2 Instructions and training related to respirators is to include:
 - .1 Limitations of the equipment.
 - .2 Inspection and maintenance of the equipment.
 - .3 Fitting of the equipment.
 - .4 Disinfecting of the equipment.

1.6 WORKER PROTECTION

- .1 Respirators: Air-purifying half-face respirator equipped with N100, R100 or P100 filter.
- .2 Protective clothing: Full body covering, including head covering and snug fitting cuffs at wrists, ankles, and neck; constructed of a material that will not permit penetration of asbestos fibres (Tyvek suit, or equivalent, with hood).
- .3 Utilize eye protection and rubber gloves during abatement activities.
- .4 Clothing: Disposable type, capable of withstanding damp wiping, and/or limited washing, as recommended by the manufacturer's information. Protective clothing is to be made of either a polyolefin or a polypropylene fabric type or an approved equal material.

- .5 Footwear: Type that will prevent fibre penetration and is capable of being damp wiped.
- .6 Eating, drinking, chewing, and smoking are not permitted in the work area.
- .7 Before leaving the work area, workers are to decontaminate protective clothing using a HEPA vacuum or by damp wiping. Store protective clothing in a clean plastic bag for reuse, or if protective clothing is not to be reused, dispose as contaminated waste. Close waste containers using twine rope, with a bag or bowline type knot.
- .8 Provide facilities for washing of hands and face when leaving the work area.

Part 2 Products

2.1 MATERIALS

- .1 Polyethylene: Polyethylene sheeting, 0.15 mm (6 mil) thickness.
- .2 FR Polyethylene: Woven fibre reinforced fabric bonded on both sides with polyethylene.
- .3 Waste Containers: Waste is to be contained in two separate containers. The inner container is to be a sealable FR polyethylene waste bag. The outer container is to be a sealable polyethylene bag. Waste containers are to have a pre-printed cautionary asbestos warning in both official languages, clearly visible when ready for removal to the disposal site.

DANGER
CONTAINS ASBESTOS FIBRES
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD
DANGER

- .4 Tape: Tape suitable for sealing polyethylene to surfaces under both wet conditions using amended water and dry conditions.
- .5 HEPA Vacuum: Vacuum with all necessary fittings, tools and attachments. All air must pass HEPA filter before discharge.

Part 3 Execution

3.1 PROCEDURES

- .1 Before beginning Work, at each access to Asbestos Work Area, install warning signs in both official languages in upper case 'Helvetica Medium' letters reading as follows, where number in parentheses indicates font size to be used:

'CAUTION ASBESTOS HAZARD AREA (25 mm)/
NO UNAUTHORIZED ENTRY (19 mm)

**WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm)
BREATHING ASBESTOS DUST MAY CAUSE SERIOUS
BODILY HARM (7 mm)'.**

- .2 Before beginning the work, remove visible dust from the surfaces in the work area, where dust is likely to be disturbed during the course of the work. Use HEPA vacuum or damp cloths, where damp cleaning does not create a hazard and is otherwise appropriate. Do not use compressed air to clean up or remove dust from any surface.
- .3 Prevent the spread of dust from the work area using measures appropriate to the work to be done. Use (FR) polyethylene drop sheets over flooring such as carpeting that absorbs dust, and over all flooring in work areas where dust and contamination cannot otherwise be safely contained. Clean drop sheets that will be reused, using a vacuum equipped with a HEPA filter, or by damp wiping. Prevent spread of asbestos in the work area where practicable by disabling the ventilation system or sealing the ducts to and from the work area.

3.2 CLEANUP

- .1 Frequently during the work, and immediately after completion of the work, clean up dust and waste containing asbestos using a HEPA vacuum or by damp mopping.
- .2 Place dust and waste containing asbestos in sealed dust-tight waste containers. Treat drop sheets and disposable protective clothing as asbestos waste and be wet and fold to contain dust, then place in waste bags.
- .3 Immediately before their removal from the work area and disposal, clean each filled waste bag, using damp cloths or a HEPA vacuum, and place in the second clean waste bag.
- .4 Seal and remove waste containers from the site. Dispose in accordance with the requirements of Provincial and Federal authority having jurisdiction. Supervise the dumping and insure that the landfill operator is fully aware of the hazardous nature of the material to be dumped, and that the guidelines and regulations for asbestos disposal are followed.
- .5 Upon completion of the work, damp wipe or vacuum clean power tools, hand tools, and equipment using a HEPA filter equipped vacuum. Dispose wiping cloths in waste containers as specified.
- .6 Perform final thorough clean-up of the work areas and adjacent areas affected by the work, using a HEPA vacuum.
- .7 Perform final review carried out by the abatement contractor to ensure no dust or debris remains.

3.3 DISPOSAL

- .1 Dispose of asbestos waste in accordance with requirements of Provincial authority having jurisdiction.

- .2 Co-operate with Ministry of Environment inspectors and immediately carry out instructions for remedial work at landfill at no extra cost.
- .3 Ensure landfill operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.
- .4 Provide the Departmental Representative with a copy of receipt, issued by landfill operator, for disposed asbestos waste.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Perform asbestos removal by Type 2 Asbestos Abatement procedures.
 - .1 Removal or disturbance of one square meter (1 m²) or less of friable asbestos-containing material during the repair, alteration, maintenance, or demolition of all or part of machinery or equipment or a building.
 - .2 Enclosing friable asbestos containing material.
 - .3 Applying tape or sealant or other covering to pipe or boiler insulation containing asbestos.
 - .4 Removing non-friable asbestos containing material by breaking, cutting, drilling, abrading, grounding, sanding or vibrating if:
 - .1 The material is not wetted to control the spread of dust or fibres, and
 - .2 The work is done only by means of non-powered hand-held tools.
 - .5 Removing non-friable asbestos containing materials by breaking, cutting, drilling, abrading, grounding, sanding or vibrating if the work is done by means of power tools that are attached to dust-collecting devices equipped with HEPA filters.
 - .6 Installing or removing of asbestos containing suspended ceiling tiles, if the tiles cover an area of 7.5 square meters or more and are installed or removed without being broken, cut, drilled, abraded, ground, sanded or vibrated.
 - .7 Removing one square meter or more of drywall in which joint filling compounds that are asbestos-containing material have been used.
 - .8 Removal of asbestos-containing material from pipes, ducts, or similar structure using a glove bag.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-2003, Sealer for Application of Asbestos Fibre Releasing Materials.
- .2 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
- .3 Manitoba Government
 - .1 Manitoba Workplace Safety and Health Act and Regulation.
- .4 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
- .5 Underwriters' Laboratories of Canada (ULC)

1.3 DEFINITIONS

- .1 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.
- .2 Asbestos Containing Materials (ACMs): materials that contain 0.5% or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.
- .3 Asbestos Work Area: area where work takes place that will or may disturb ACMs.
- .4 Authorized Visitors: Departmental Representative, and representatives of regulatory agencies.
- .5 Competent worker person: in relation to specific work, means a worker who:
 - .1 Is qualified because of knowledge, training and experience to perform the work.
 - .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.
 - .3 Has knowledge of all potential or actual danger to health or safety in the work.
- .6 Friable Materials: material that, when dry, can be crumbled, pulverized, or powdered by hand pressure, and includes such material that is crumbled, pulverized, or powdered.
- .7 Glove Bag: prefabricated glove bag as follows:
 - .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
 - .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
 - .3 Equipped with reversible double-pull, double-throw zipper on top and at approximately mid-section of the bag.
 - .4 Straps for sealing ends around pipe.
 - .5 Incorporated internal closure strip if bag is to be moved or used in more than one specific location.
- .8 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any dimension at 99.97% efficiency.
- .9 Non-Friable Material: material that, when dry, cannot be crumbled, pulverized, or powdered by hand pressure.
- .10 Occupied Area: any area of building or work site that is outside Asbestos Work Area.
- .11 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.

- .12 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for scope of work.

1.4 REGULATORY REQUIREMENTS

- .1 Comply with Federal, Provincial and local requirements pertaining to asbestos. In case of conflict among these requirements or with these specifications, the more stringent requirement applies. Comply with regulations in effect at the time the work is preformed.
- .2 Comply with:
 - .1 Manitoba Workplace Safety and Health Act (W210).
 - .2 Manitoba Workplace Safety and Health Regulation (MR 217/2006).
 - .3 Safe Work Manitoba "Guide for Asbestos Management," dated June 2016.
 - .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-03, Sealer for Application of Asbestos Fibre Releasing Materials.
 - .5 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
 - .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
 - .8 Policies and procedures of the Building Operations Management. All material handling and associated equipment must conform to and be operated in accordance with "Work Place Materials Information System" (WHMIS).

1.5 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit proof satisfactory to the Departmental Representative that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction. Provide Bill of Lading to Departmental Representative.
- .3 Submit to Departmental Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.
- .4 Submit proof, satisfactory to Departmental Representative, that all employees have had instructions on hazards of asbestos exposure, respirator use, dress, entry and exit from Asbestos Work Area, and all aspects of work procedures and protective measures.

- .5 Submit proof that supervisory personnel have attended an asbestos abatement course of not less than two days' duration, and approved by Departmental Representative. Minimum of one supervisor for every ten workers.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Place materials defined as hazardous or toxic in designated containers.
- .4 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional, and Municipal regulations.
- .5 Provide the Departmental Representative with a copy of receipt for disposed asbestos waste issued by landfill operator.
- .6 Disposal of asbestos waste in accordance with requirements of Provincial authority having jurisdiction.

1.7 EXISTING CONDITIONS

- .1 Reports and information pertaining to ACMs to be handled, removed, or otherwise disturbed and disposed of during this Project provided in Annex A – Hazardous Building Materials Assessment.
- .2 Notify Departmental Representative of friable material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Departmental Representative.

1.8 WORKER PROTECTION

- .1 Protective equipment and clothing to be worn by workers while in Asbestos Work Area include:
 - .1 Air-purifying full-face piece respirator with N100, R100 or P100 particulate filter cartridges, personally issued to the worker and marked as to efficiency and purpose, suitable for protection against asbestos, and acceptable to the Provincial Authority having jurisdiction.
 - .2 Disposable-type protective clothing that does not readily retain or permit penetration of asbestos fibres, consisting of full-body covering, including head covering with snug-fitting cuffs at wrists, ankles, and neck.
- .2 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.
- .3 Before leaving the Asbestos Work Area, dispose of protective clothing as contaminated waste as specified.

- .4 Ensure workers wash hands and face when leaving Asbestos Work Area. Facilities for washing are located within or close to Asbestos Work Area.
- .5 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects the seal between the respirator and the face.

1.9 INSTRUCTIONS AND TRAINING

- .1 Provide the following prior to project start-up:
 - .1 Submit proof to the Departmental Representative that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction.
 - .2 Submit proof satisfactory to Departmental Representative that all employees have had instructions on hazards of asbestos exposure, respirator use, dress, entry and exit from Asbestos Work Area, and all aspects of work procedures and protective measures.
 - .3 Submit proof that supervisory personnel have attended an industry approved asbestos abatement course, of not less than two days duration. Minimum of one supervisor for every ten workers.
- .2 Instruction and training related to respirators includes, at a minimum:
 - .1 Fitting of equipment.
 - .2 Inspection and maintenance of equipment.
 - .3 Disinfecting of equipment.
 - .4 Limitations of equipment.
- .3 Instruction and training must be provided by a competent, qualified person.

1.10 VISITOR PROTECTION

- .1 Provide protective clothing and approved respirators to Authorized Visitors to Asbestos Work Area.
- .2 Instruct Authorized Visitors in use of protective clothing, respirators, and procedures.
- .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from Asbestos Work Area.

Part 2 Products

2.1 MATERIALS

- .1 Drop and Enclosure Sheets:
 - .1 Polyethylene: 0.15 mm thick.
 - .2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.

- .2 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos-containing material.
- .3 Waste Containers: contain waste in two separate containers.
 - .1 Inner container: 0.15 mm thick sealable polyethylene bag (where glove bag method is used, the glove bag itself).
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
 - .3 Labelling requirements: affix preprinted cautionary asbestos warning, in both official languages, that is visible when ready for removal to disposal site.
- .4 Glove bag:
 - .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
 - .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
 - .3 Equipped with reversible double-pull double throw zipper on top.
 - .4 Straps for sealing ends around pipe.
 - .5 Must incorporate internal closure strop if it is to be moved or used in more than one specific location.
- .5 Tape: suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.
- .6 Slow-drying sealer: non-staining, clear, water-dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
 - .1 Sealer: flame spread and smoke developed rating less than 50, and non-toxic.
- .7 Encapsulant: surface film forming, penetrating type, conforming to CAN/CGSB-1.205, ULC listed having following flame spread rating less than 25 and smoke development rating less than 50, and non-toxic.

Part 3 Execution

3.1 SUPERVISION

- .1 Minimum of one Supervisor for every ten workers is required.
- .2 Approved Supervisor must remain within Asbestos Work Area during disturbance, removal, or other handling of asbestos-containing materials.

3.2 PROCEDURES

- .1 Before beginning Work, at each access to Asbestos Work Area, install warning signs in both official languages in upper case 'Helvetica Medium' letters reading as follows, where number in parentheses indicates font size to be used:

**'CAUTION ASBESTOS HAZARD AREA (25 mm)/
NO UNAUTHORIZED ENTRY (19 mm)
WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm)
BREATHING ASBESTOS DUST MAY CAUSE SERIOUS
BODILY HARM (7 mm)'.
'**

- .2 Before beginning Work, remove visible dust from surfaces in work area where dust is likely to be disturbed during course of work.
 - .1 Use HEPA vacuum or damp cloths where damp cleaning does not create hazard and is otherwise appropriate.
 - .2 Do not use compressed air to clean up or remove dust from any surface.
- .3 Prevent spread of dust from Asbestos Work Area, using measures appropriate to work to be done.
 - .1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust, and over flooring in work areas where dust or contamination cannot otherwise be safely contained.
- .4 Before removing suspended ceilings, remove friable material on upper surfaces using HEPA vacuum equipment.
 - .1 Remove and clean surfaces of ceiling panels using HEPA vacuum, wrap clean panels in 0.10 mm thick polyethylene, and store in building as directed by Departmental Representative.
- .5 Other than loose material to be removed by a HEPA vacuum, friable material containing asbestos.
- .6 Pipe Insulation Removal Using Glove Bag:
 - .1 A glove bag is not to be used to remove insulation from a pipe, duct or similar structure if:
 - .1 It may not be possible to maintain a proper seal for any reason including, without limitation:
 - .1 The condition of the insulation.
 - .2 The temperature of the pipe, duct, or similar structure.
 - .2 The bag could become damaged for any reason including, without limitation.
 - .1 The type of jacketing.
 - .2 The temperature of the pipe, duct, or similar structure.

- .2 Upon installation of the glove bag, inspect bag for damage and defects. If damage or defects are found, repair or replace glove bag. Inspect glove bag at regular intervals for damage and defects, and repair or replace as appropriate. The asbestos-containing contents of the damaged or defective glove bag found during removal are to be wetted and the glove bag and its contents are to be removed and disposed of in an appropriate waste disposal container. Any damaged or defective glove bags are not be reused.
- .3 If bag is to be moved along pipe, first remove air from top section through elasticized valve using HEPA vacuum. Next loosen straps, move bag, and re-seal to pipe using double-pull zipper to pass hangers. Repeat stripping operation.
- .4 When glove bags are intended for use at more than one location: after wash-down and application of sealer, seal off waste in lower section of bag using zipper at mid-section of bag. Remove air from top section of bag through elasticized valve using HEPA vacuum. Remove bag from pipe, reinstall in new location, and reseal to pipe prior to opening lower section of bag. Repeat stripping operation.
- .5 Place tools necessary to remove insulation in tool pouch. Wrap bag around pipe and close zippers. Seal bag to pipe with cloth straps.
- .6 Place hands in gloves and use necessary tools to remove insulation. Arrange insulation in bag to obtain full capacity of bag.
- .7 Insert nozzle of garden reservoir type sprayer into bag through valve and wash down pipe and interior of bag thoroughly. Wet surface of insulation in lower section of bag.
- .8 To remove bag after completion of stripping, wash top section and tools thoroughly. Remove air from top section through elasticized valve using a HEPA vacuum. Pull polyethylene waste container over glove bag before removing from pipe. Release one strap and remove freshly washed tools. Place tools in water. Remove second strap and zipper. Fold over into waste container and seal.
- .9 After removal of bag ensure that pipe is free of residue. Remove residue using HEPA vacuum or wet cloths. Ensure that surfaces are free of sludge which, after drying, could release asbestos dust into atmosphere. Seal exposed surfaces of pipe and ends of insulation with slow drying sealer to seal in any residual fibres.
- .10 Upon completion of Work shift, cover exposed ends of remaining pipe insulation with polyethylene taped in place.
- .7 All Work is subject to visual inspection and air monitoring. Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas.
- .8 Cleanup:
 - .1 Frequently during Work and immediately after completion of work, clean up dust and asbestos-containing waste using HEPA vacuum or by damp mopping.

- .2 Place dust and asbestos containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste; wet and fold to contain dust and then place in waste bags.
- .3 Immediately before their removal from Asbestos Work Area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.
- .4 Seal and remove double bagged waste from site. Dispose of in accordance with requirements of Provincial/Territorial and Federal authority having jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped, and that guidelines and regulations for asbestos disposal are followed.
- .5 Perform final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

3.3 AIR MONITORING

- .1 From beginning of Work until completion of cleaning operations, Abatement Contractor to take air samples on daily basis outside of Asbestos Work Area enclosures in accordance with Provincial Occupational Health and Safety Regulations.
 - .1 Contractor will be responsible for monitoring inside enclosure in accordance with applicable Provincial Occupational Health and Safety Regulations.
- .2 If air monitoring shows that areas outside Asbestos Work Area enclosures are contaminated, enclose, maintain, and clean these areas in same manner as Asbestos Work Area.
- .3 Ensure that respiratory safety factors are not exceeded.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A500/A500M-10, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- .2 Canadian Standards Association (CSA)
 - .1 CAN/CSA G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 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 bollards. Include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 29 – Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Indicate materials, core thicknesses, finishes, connections, method of anchorage, supports, reinforcement, details, and accessories.

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 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 Replace defective or damaged materials with new.

Part 2 Products

2.1 BOLLARDS

- .1 Steel bollards: To ASTM A500, Schedule 80 steel pipe, dimensions as shown in drawings.
 - .1 Shop finish: Galvanized to CAN/CSA G164.
 - .2 Site finish: Paint – refer to Section 09 91 00.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions are acceptable for bollard installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 ERECTION

- .1 Erect bollards square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .2 Supply components for work by other trades in accordance with shop drawings and schedule.
- .3 Deliver items over for casting into concrete together with setting templates to appropriate location and construction personnel.

3.3 BOLLARDS

- .1 Set bollard in concrete as shown in drawings.
- .2 Fill installed bollard with concrete, finished with crown cap.
 - .1 Concrete: in accordance with Structural drawings.

3.4 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by bollard installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A123/A123M-13, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A653/A653M-13, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction and amendment.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B111-1974 (R2003), Wire Nails, Spikes and Staples.
 - .2 CSA O80-Series-08, Wood Preservation.
 - .3 CSA O112.9-10 (R2014), Evaluation of Adhesives for Structural Wood Products (Exterior Exposure).
 - .4 CSA O121-08 (R2013), Douglas Fir Plywood.
 - .5 CSA O141-05 (R2014), Softwood Lumber.
 - .6 CSA O151-09 (R2014), Canadian Softwood Plywood.
 - .7 CSA O325-07 (R2012), Construction Sheathing.
- .4 National Lumber Grades Authority (NLGA)
 - .1 NLGA Standard Grading Rules for Canadian Lumber (2014 edition).

1.2 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB, and wood based composite panels in accordance with CSA and ANSI standards.

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 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 wood from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 FRAMING STRUCTURAL AND PANEL MATERIALS

- .1 Lumber: Softwood, S4S, moisture content 19% (S-dry) or less in accordance with following standards:
 - .1 CSA O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
- .2 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
 - .1 Use S2S or S4S materials.
 - .2 Board sizes: "Standard" or better grade.
 - .3 Dimension sizes: "Standard" light framing or better grade.
- .3 Plywood, OSB and wood based composite panels: CSA O325.
- .4 Douglas fir plywood (DFP): CSA O121, standard construction.
- .5 Canadian softwood plywood (CSP): CSA O151, standard construction.
- .6 Treated wood products: To CSA O80 Series.
- .7 Fire retardant treated wood: To CAN/ULC S102.
 - .1 Flame spread: Maximum 25.
 - .2 Smoke developed: Maximum 25.

2.2 ACCESSORIES

- .1 Polyethylene film: To CAN/CGSB 51.34, Type 1, 0.15 mm thick.
- .2 Air seal: Closed cell polyurethane or polyethylene.
- .3 Sealants: In accordance with Section 07 92 00 - Joint Sealants.
- .4 General purpose adhesive: CSA O112.9.
- .5 Nails, spikes and staples: CSA B111.
- .6 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- .7 Proprietary fasteners: Toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, recommended for purpose by manufacturer.
- .8 Fasteners: Hot dipped galvanized steel to ASTM A123/A123M or ASTM A653/A653M for high humidity and treated wood locations; unfinished steel elsewhere.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for product installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 FURRING AND BLOCKING

- .1 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, audio-visual equipment mounting, electrical equipment mounting boards, wall-mounted acoustic panels, coat rod mounting flanges, architectural hardware, bathroom accessories, fire extinguisher brackets, and other work as required.
 - .1 Install continuous plywood blocking as indicated.
- .2 Install rough bucks, nailers, and linings to rough openings as required to provide backing for frames and other work.
- .3 Install nailers, curbs, and other wood supports as required, and secure using galvanized steel fasteners.

3.3 EQUIPMENT/ELECTRICAL MOUNTING BOARD

- .1 Equipment/Electrical mounting board:
 - .1 Douglas Fir plywood, good one side.
 - .2 Size: 1220 x 2440 mm x 19 mm (48 x 96 x ¾ inch).
 - .3 Finish: Intumescent paint finish, refer to Section 09 91 00 – Painting; white or to match wall colour unless otherwise specified; finish on all six surfaces prior to installation to ensure proper sealing.
 - .4 Fastening: Exposed stainless steel fasteners, at 400 mm (16 inches) o.c. unless otherwise specified.

3.4 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by rough carpentry installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/BHMA A156.9-2010, Cabinet Hardware.
 - .2 ANSI A208.1-09, Particleboard.
 - .3 ANSI A208.2-09, Medium Density Fiberboard (MDF) for Interior Applications.
- .2 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
 - .1 Architectural Woodwork Standards, 2nd Edition, 2014.
- .3 Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI/BHMA A156.9-2015, Cabinet Hardware.
 - .2 ANSI/BHMA A156.11-2014, Cabinet Locks.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 71.20-M88, Adhesive, Contact, Brushable.
- .5 Canadian Standards Association (CSA)
 - .1 CSA B111-74 (R2003), Wire Nails, Spikes and Staples.
 - .2 CSA O112.10-08 (R2013), Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure).
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 National Electrical Manufacturers Association (NEMA)
 - .1 ANSI/NEMA LD3-2005, High-Pressure Decorative Laminates (HPDL).
- .8 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber, 2014.

1.2 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 architectural woodwork; include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS for products used in the project.
- .3 Shop Drawings:
 - .1 Indicate details of construction, profiles, jointing, fastening and other related details.

- .1 Scales: profiles full size, details half full size.
- .2 Indicate materials, thicknesses, finishes and hardware.
- .3 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.
- .4 Samples:
 - .1 Submit duplicate manufacturer's samples of high-pressure decorative laminate for pattern and colour selection.
- .5 Certifications: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB, and wood based composite panels to CSA and NPA standards.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
 - .1 Protect millwork against dampness and damage during and after delivery.
 - .2 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect architectural woodwork from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Softwood lumber: Unless specified otherwise, S4S, moisture content 19% or less in accordance with following standards:
 - .1 CSA O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
 - .3 AWMAC Custom grade, moisture content as specified.
- .2 Machine stress-rated lumber is acceptable for all purposes.

- .3 Particleboard core: To NPA A208.1, Grade M2 or better.
 - .1 Thickness swelling: Maximum 5.5%.
 - .2 Modulus of rupture: Minimum 13.0 N/mm² (1885 psi).
- .4 Moisture-resistant MDF: To ANSI/NPA A208.2, Grade 155 MR50.
- .5 High pressure decorative laminate (HPDL) for horizontal surfaces: To NEMA LD3, Horizontal Grade Standard (HGS), 1.2 ± 0.12 mm thick.
- .6 HPDL for vertical surfaces: To NEMA LD3, Vertical Grade Standard (VGS), 0.7 mm ± 0.10 mm thick.
- .7 HPDL for postforming work: To NEMA LD3, Horizontal Grade Postforming (HGP), 1.0 ± 0.12 mm thick.
- .8 Thermofused Melamine: To NEMA LD3, melamine, polyester, or foil resin impregnated paper thermally fused under pressure to an approved core.
 - .1 High wear resistant thermofused melamine: Equal or exceed 400 cycles (Minimum standard for HPL abrasion test).
- .9 Nails and staples: To CSA B111.
- .10 Wood screws: Stainless steel, type and size to suit application.
- .11 Splines: Metal.
- .12 Sealant: In accordance with Section 07 92 00 - Joint Sealants.
- .13 Laminate adhesive:
 - .1 Adhesive: Contact adhesive to CAN/CGSB 71.20.

2.2 HARDWARE

- .1 General:
 - .1 Hardware: ANSI/BHMA A156.9.
 - .2 Finish: Brushed nickel or stainless steel, unless otherwise specified.
- .2 Hinges: European style hinges, 110° minimum opening, soft closing.
- .3 Drawer and Door Pulls: Square profile, flush mounted, closed end.
 - .1 Sizes:
 - .1 150 mm: For doors, and for drawers less than 750 mm width.
 - .2 250 mm: For drawers greater than 750 mm wide, and for doors taller than 900 mm.
 - .2 Acceptable product: Richelieu 873.
 - .1 Confirm product selection with Departmental Representative.
- .4 Catches: Type I – magnetic catch.
- .5 Adjustable shelf standards and supports: Vertical slotted shelf standard, type B04102.
- .6 Drawer slides: Full extension, side-mounted drawer slides with ball bearings, zinc coated steel, 30 kg (66 lb) load capacity, soft closing.

- .7 Fixed brackets: For cantilevered surfaces, steel angle welded to wall-mounting plate for, 150 kg capacity per pair, prime paint finish, pre-drilled holes for screw attachment to substrate and table top.
- .8 Hanging file rails: Heavy duty, 13 mm (1/2 inch) wide, steel, complete with mounting clips.
- .9 Paper towel dispenser: Countertop mounted, recessed mounting with flange, hinged towel retainers and spring-loaded tray, Type 304 stainless steel, 0.8 mm (22 gauge) thickness, all welded construction, satin finish for exposed surfaces.
 - .1 Capacity: 300 C-fold or multi-fold paper towels.
- .10 Louver vent: Extruded aluminum, bar grille with flanged frame.
 - .1 Bar spacing: Maximum 10 mm.
- .11 Coat rods: To ANSI A156.9, heavy duty round steel tubing, polished chrome finish.
 - .1 Outside diameter: Minimum 27 mm (1-1/16 inch).
 - .2 Wall thickness: Minimum 2.2 mm (0.087 inch).
 - .3 Mounting brackets: Round, closed flange, cast zinc, minimum three-screw attachment.

2.3 MANUFACTURED UNITS

- .1 All work to AWMAC Custom grade.
- .2 Core: Particleboard.
- .3 Casework:
 - .1 Construction type: Frameless.
 - .2 Cabinet and door interface: Flush overlay.
 - .3 Exposed surfaces: HPDL.
 - .4 Exposed interior surfaces: HPDL, to match exposed surfaces.
 - .5 Semi-exposed surfaces: Thermofused melamine, white, unless indicated otherwise.
 - .6 Edgeband: 3 mm PVC, colour as selected by Departmental Representative.
 - .1 Adjustable shelves: Apply edgeband to all four sides.
 - .7 Ladder base: Canadian softwood plywood, 19 mm thick.
 - .1 Kitchenette: Mount 6 mm moisture-resistant MDF to front face of ladder base, HPDL finish.
 - .8 Toe kicks/base fronts: HPDL.
- .4 Doors/drawers:
 - .1 Fronts: HPDL.
 - .2 Semi-exposed surfaces: Thermofused melamine, white.
 - .3 Concealed surfaces: Thermofused melamine, white.
 - .4 Edgeband: 3 mm PVC, colour as selected by Departmental Representative.

- .5 File drawers: Provide hanging file rails.
- .5 Laminate countertops:
 - .1 Horizontal surfaces: HPDL.
 - .2 Front edges: 3 mm PVC, colour as selected by Departmental Representative.
- .6 Window sills:
 - .1 Horizontal surfaces: HPDL.
 - .2 Front edges: Self-edge.

2.4 FABRICATION

- .1 Set nails and countersink screws apply plain wood filler to indentations, sand smooth and leave ready to receive finish.
- .2 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .3 Shelving to cabinetwork to be adjustable unless otherwise noted.
- .4 Provide cut-outs for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.
- .5 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.
- .6 Obtain governing dimensions before fabricating items that are to accommodate or abut appliances, equipment and other materials.
- .7 Ensure adjacent parts of continuous laminate work match in colour and pattern.
- .8 Veneer laminate to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 2400 mm. Keep joints 600 mm from sink cut-outs.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for architectural woodwork installation in accordance with manufacturer's instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Perform architectural woodwork to Quality Standards of AWMAC.
- .2 Install prefinished millwork at locations shown on drawings.

- .1 Position accurately, level, plumb, and straight.
- .3 Fasten and anchor millwork securely.
 - .1 Supply and install heavy duty fixture attachments for wall mounted cabinets.
- .4 Use draw bolts in countertop joints.
- .5 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.
- .6 At junction of laminate counter and adjacent wall finish, apply small bead of silicone sealant in accordance with Section 07 92 00 - Joint Sealants.
- .7 Apply water resistant building paper over wood framing members in contact with masonry or cementitious construction.
- .8 Fit hardware accurately and securely in accordance with manufacturer's written instructions.

3.3 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
 - .1 Clean millwork outside surfaces, and inside cupboards and drawers.
 - .2 Remove excess glue from surfaces.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.4 PROTECTION

- .1 Protect millwork from damage until final inspection.
- .2 Protect installed products and components from damage during construction.
- .3 Repair damage to adjacent materials caused by architectural woodwork installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM E84-17, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 ASTM E736-00 (2015)e1, Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
 - .3 ASTM E759/E759M-92 (2015)e1, Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.
 - .4 ASTM E760/E760M-92 (2015)e1, Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members.
 - .5 ASTM E761/E761M-92 (2015)e1, Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members.
 - .6 ASTM E1354-17, Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets; include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29 – Health and Safety Requirements.
- .3 Quality assurance submittals: Submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.3 QUALITY ASSURANCE

- .1 Mock-ups:
 - .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
 - .2 Apply fireproofing to approximately 1 m² area of surfaces of mock-up-matching surface to be treated.
 - .3 Mock-up will be used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
 - .2 For testing to determine compliance with performance
 - .4 Locate where directed.
 - .5 Allow for inspection of mock-up by Departmental Representative before proceeding with fireproofing work.
 - .6 When accepted, mock-up will demonstrate minimum standard of quality required for this work.
 - .7 Approved mock-up may remain as part of finished work

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling, and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver packaged materials in original unopened containers, marked to indicate brand name and manufacturer.
- .2 Storage and Protection:
 - .1 Store materials indoors in dry location.
 - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.
 - .3 Damaged or opened containers will be rejected.
 - .4 Packaging to indicate shelf-life and materials to be applied prior to expiration of shelf-life.
 - .5 Provide temporary enclosures to prevent spray from contaminating air beyond application area.
 - .6 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of fireproofing materials.
- .3 Waste Management and Disposal: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

1.5 AMBIENT CONDITIONS

- .1 Ensure that minimum 5°C air and substrate temperature is maintained during and for 24 hours after application.
- .2 Ensure that natural ventilation is provided to properly dry fireproofing during and after application. In enclosed areas lacking openings for natural ventilation, ensure that interior air is circulated and exhausted to the outside.
- .3 Maintain relative humidity within limits recommended fireproofing manufacturer.

Part 2 Products

2.1 MATERIALS

- .1 Sprayed fireproofing: ULC certified cementitious or asbestos-free mineral fibre fireproofing.
 - .1 Bond strength (ASTM E736): Minimum 9.6 kPa (200 psf).
 - .2 Compression, 10% deformation (ASTM E761): Minimum 51 kPa (1200 psf).
 - .3 Bond impact (ASTM E760): No cracking, spalling, or delamination.
 - .4 Deflection (ASTM E759): No cracking, spalling, or delamination.
 - .5 Surface burning characteristics (ASTM E84):
 - .1 Flame spread: 0.
 - .2 Smoke developed: 0.
 - .6 Combustibility (ASTM E1354): < 5 MJ/m² total, 20 kw/m² peak heat release.
- .2 Curing compound: type recommended by fireproofing manufacturer.
- .3 Sealer: type recommended by fireproofing manufacturer.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PREPARATION

- .1 Substrate: Free of material that would impair bond.
- .2 Verify painted substrates are compatible and have suitable bonding characteristics to receive fireproofing.
- .3 Remove incompatible materials.
- .4 Ensure that items required to penetrate fireproofing are placed before installation of fireproofing.

- .5 Ensure that ducts, piping, equipment, or other items that would interfere with application of fireproofing are not positioned until fireproofing work is completed.

3.3 APPLICATION

- .1 Apply bonding adhesive or primer to substrate if recommended by manufacturer.
- .2 Apply fireproofing to correspond with tested assemblies, or acceptable calculation procedures to provide following fire resistance rating as indicated.
- .3 Apply fireproofing over substrate, building up to required thickness to cover substrate with monolithic blanket of uniform density and texture.
- .4 Apply fireproofing directly to open web joists without use of expanded lath.
- .5 Apply curing compound to surface of cementitious fireproofing as required by manufacturer.

3.4 PATCHING

- .1 Patch damage to fireproofing caused by testing or by other trades before fireproofing is concealed, or if exposed, before final inspection.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Clean surfaces not indicated to receive fireproofing of sprayed material within 24 hour period after application.
- .3 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 REFERENCES

- .1 ASTM International
 - .1 ASTM D2240-05 (2010), Standard Test Method for Rubber Property – Durometer Hardness.
 - .2 ASTM D2794-93 (2010), Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - .3 ASTM D4541-09e1, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - .4 ASTM E84-12, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.2 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 intumescent coating application and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29 - Health and Safety Requirements.

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 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.4 SITE CONDITIONS

- .1 Environmental Requirements:
 - .1 Temperature: minimum temperature of substrate 10°C. Minimum temperature of air during and for 48 hours before and after coating is applied 15°C.
- .2 Ventilation:
 - .1 Provide continuous ventilation during and after coating application.

Part 2 Products

2.1 MATERIALS

- .1 Coating: Factory-blended multicomponent system consisting of primer and top coat, applied in sufficient thickness to achieve indicated fire resistance rating.
 - .1 Surface burning characteristics (ASTM E84):
 - .1 Flame spread: 0.
 - .2 Smoke developed: Maximum 20.
 - .2 Durometer hardness, Shore D (ASTM D2240): Minimum 65.
 - .3 Impact resistance (ASTM D2794): 18 nm (160 inch-lb).
 - .4 Bond strength (ASTM D4541): Minimum 3300 kPa (485 psi).

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate are acceptable for intumescent coating application in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Ensure that items penetrating coating are placed before application of coating.
 - .3 Inform Departmental Representative of unacceptable conditions.
 - .4 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

- .1 Protect adjacent surfaces and equipment from damage by over spray, fall-out and dusting.
- .2 Clean substrate of matter which would affect bond of coating.

3.3 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written application recommendations.
- .2 Prepare substrate for application of intumescent coating to manufacturer's directions.
- .3 Prime surfaces according to manufacturer's directions, allow to dry.
- .4 Apply coating to a small test area and allow to set. Notify Departmental Representative to inspect mock-up.
- .5 Apply additional coats as required to achieve dry film thickness to achieve fire resistance rating indicated.

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 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Repair damage to adjacent materials caused by intumescent coating application.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM E2174-14 – Standard Practice for On-Site Inspection of Installed Firestops.
 - .2 ASTM G21-15, Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 Firestop Contractors International Association (FCIA)
 - .1 FCIA Firestop Industry Manual of Practice, 5th Edition.
- .3 FM Global (FM)
 - .1 FM Approvals 4991 – Approval of Firestop Contractors.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA 101 – Life Safety Code, 2012 Edition.
- .6 UL (formerly Underwriters Laboratories)
 - .1 UL 1479 – Standard for Fire Tests of Through-Penetration Firestops.
 - .2 UL 2079 – Standard for Tests for Fire Resistance of Building Joint Systems.
- .7 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC S101-14 – Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC S102-10 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC S115-11 - Fire Tests of Firestop Systems.

1.2 DEFINITIONS

- .1 Fire Stop Material: Device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: Fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: Exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.

- .4 Tightly Fitted (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): Penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
 - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.3 PERFORMANCE REQUIREMENTS

- .1 Materials, accessories, and application procedures: Listed by ULC, cUL, or tested in accordance with CAN/ULC S115 to comply with applicable building code requirements.
- .2 Firestopping materials: To CAN/ULC S101, to achieve fire rating as noted on Drawings and ULC Design Number shown.

1.4 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications, and datasheets. Include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets.
- .3 Shop Drawings:
 - .1 Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings, and method of installation.
 - .2 Ensure construction details accurately reflect actual job conditions.
- .4 System Design Listings, including illustrations from a qualified testing and inspection agency as applicable for each firestop configuration.
- .5 Samples:
 - .1 Submit duplicate 200 x 200 mm samples showing actual fire stop material proposed for project.
- .6 Quality Assurance Submittals: Submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: In accordance with CAN/ULC S101 for fire endurance and CAN/ULC S102 for surface burning characteristics.
 - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: Signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: Including special handling criteria, installation sequence, and cleaning procedures.

- .7 Project Record Documentation: Supply documentation for each single application addressed. Identify each penetration and joint location on entire project. Provide at completion of project.
 - .1 Include the following for through-penetrations:
 - .1 Sequential location number.
 - .2 Project name.
 - .3 Installation date.
 - .4 Detailed description of penetration location.
 - .5 Tested System or Engineered Judgment Number.
 - .6 Type of assembly penetrated.
 - .7 Detailed description of size and type of penetrating item.
 - .8 Size of opening.
 - .9 Number of sides of assemblies addressed.
 - .10 Hour rating achieved.
 - .11 Installer's name.
 - .2 Include the following for construction joints:
 - .1 Sequential location number.
 - .2 Project name.
 - .3 Installation date.
 - .4 Detailed description of construction joint location.
 - .5 Tested System or Engineered Judgment Number.
 - .6 Type of construction joint.
 - .7 Width of joint.
 - .8 Lineal footage of joint.
 - .9 Number of sides of assemblies addressed.
 - .10 Hour rating achieved.
 - .11 Installer's name.

1.5 QUALITY ASSURANCE

- .1 Single Source Responsibility: Obtain firestop systems for each type of penetration and construction situation from a single primary firestop systems manufacturer.
- .2 Regulatory Requirements:
 - .1 Conform to applicable code for fire resistance ratings and surface burning characteristics.
 - .2 Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 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 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, and ULC or cUL labels.
- .3 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .4 Replace defective or damaged materials with new.
- .5 Waste Management and Disposal: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 SITE CONDITIONS

- .1 Apply materials within temperature range recommended by manufacturer.
- .2 Maintain recommended temperature before, during, and for 72 hours after installation of materials.

Part 2 Products

2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: In accordance with CAN/ULC S115.
 - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke, and gases in compliance with requirements of CAN/ULC S115 and not to exceed opening sizes for which they are intended.
 - .2 Ensure firestopping system components are fully compatible with each other, with substrates, and with items penetrating the firestopping.
 - .3 Mould and mildew resistance to ASTM G21: 0 (Zero).
- .2 Service penetration assemblies: Systems tested to CAN/ULC S115.
- .3 Service penetration fire stop components: Certified by test laboratory to CAN/ULC S115.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: Elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork, and other mechanical items requiring sound and vibration control: Elastomeric seal.
- .7 Primers: To manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): Potable, clean, and free from injurious amounts of deleterious substances.
- .9 Insulation: Mineral wool fibre semi-rigid insulation, Type 1.

- .10 Damming and backup materials, supports, and anchoring devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .11 Sealants for vertical joints: Non-sagging.
- .12 Installation Accessories: Clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 EXAMINATION

- .1 Verify existing conditions before starting work.
- .2 Verify opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping are ready to receive the work of this Section.
- .3 Proceed with installation only when unsatisfactory conditions have been corrected.

3.3 PREPARATION

- .1 Ensure substrates and surfaces are clean, dry, and frost free.
- .2 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
- .3 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .4 Maintain insulation around pipes and ducts penetrating fire separation, without interruption to vapour barrier.
- .5 Mask and use drop cloths where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.4 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to neat finish.

- .5 Remove excess compound promptly as work progresses and upon completion.

3.5 LABELLING

- .1 Provide and install identification labels for each individual penetration with firestopping.
 - .1 Install labels in readily visible location, on both sides of penetrated assembly, with permanently bonding adhesive.
 - .2 Label to include:
 - .1 Warning indicating that system is firestopping installation to be left undisturbed.
 - .2 Installing Contractor name and contact information.
 - .3 System designation of testing organization.
 - .4 Installation date.
 - .5 Manufacturer.

3.6 FIELD QUALITY CONTROL

- .1 Inspections: Notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C719-14, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement (Hockman Cycle).
 - .2 ASTM C834-05, Standard Specification for Latex Sealants.
 - .3 ASTM C919-12, Standard Practice for Use of Sealants in Acoustical Applications.
 - .4 ASTM C920-05, Standard Specification for Elastomeric Joint Sealants.
 - .5 ASTM C1193-13, Standard Guide for Use of Sealants.
 - .6 ASTM C1311-02, Standard Specification for Solvent Release Sealants.
 - .7 ASTM E814-13a, Standard Test Method for Fire Tests of Penetration Firestop Systems.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
 - .2 CGSB 19-GP-14M-1984, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing.
 - .3 CAN/CGSB 19.17-M90, One-Component Acrylic Emulsion Base Sealing Compound.
 - .4 CAN/CGSB 19.21-M87, Sealing and Bedding Compound, Acoustical.
 - .5 CAN/CGSB 19.24-M90, Multi-component, Chemical Curing Sealing Compound.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 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 joint sealants. Include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Manufacturer's product to describe:
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
 - .3 Submit 2 copies of WHMIS MSDS for products used in the Work.

- .3 Manufacturer's Instructions:
 - .1 Submit instructions to include installation instructions for each product used.

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 incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Compatibility: Verify sealants used are compatible with their respective joint substrates.
- .2 Provide sealants with appropriate expansion and contraction properties for the joints being sealed.
- .3 Perform sealant application work to ASTM C1193.
- .4 Perform structural sealant application work to ASTM C1401.
- .5 Perform acoustic sealant application work to ASTM C919.

1.5 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 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.6 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Proceed with installation of joint sealants only when:
 - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4°C.
 - .2 Joint substrates are dry.
 - .3 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 Joint-Width Conditions:

- .1 Proceed with installation of joint sealants only where joint widths are more than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Proceed with installation of joint sealants only after contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Health Canada.
- .2 Departmental Representative to arrange for ventilation system to be operated on maximum outdoor air and exhaust during installation of caulking and sealants.

Part 2 Products

2.1 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas that off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.
- .3 Where sealants are qualified with primers use only these primers.

2.2 SEALANT MATERIALS

- .1 Polyurethane Sealant: To CAN/CGSB 19.24, Type 2, Class B; and ASTM C920, Type M, Grade NS, Use NT, M, A and O; non-sag, multi component, chemical curing.
 - .1 Typical uses: Control joints in concrete floors (when no hard finish is specified), exterior joints, expansion joints, panel walls, perimeter windows.
- .2 Elastomeric Polyurethane Sealant: To CAN/CGSB 19.13, Type 2; and ASTM C920, Type S, Grade NS, Use NT, M, A and O; non-sag, single component, moisture curing hybrid polyurethane.
 - .1 Typical uses: Expansion and control joints, perimeter caulking of windows and doors.
- .3 Latex Sealant: To CAN/CGSB 19.17; and ASTM C834; single component, acrylic latex or siliconized acrylic latex.
 - .1 Typical uses: General purpose, acoustic sealing, back bedding glazing compound, window frame perimeters.
- .4 Acoustic Sealant: To CAN/CGSB 19.21 and ASTM C919, acoustic grade, single component, non-hardening, non-skinning.

- .1 Typical uses: Acoustic sealing of gypsum wall board partitions, sealing of interior polyethylene air/vapour barrier.
- .5 Acoustic and Smoke Sealant: To CAN/CGSB 19.21 and ASTM C919, acoustic grade, single component, non-hardening, non-skinning.
 - .1 Typical use: Acoustic and smoke sealing of gypsum wall board partitions.
- .6 Fire-Resistive Sealant: To ASTM E814, one part fire-stopping sealant.
 - .1 Typical uses: Penetrations in fire-rated floor and wall assemblies.
 - .2 Refer to Section 07 84 00 – Fire Stopping.
- .7 Silicone, one part: To CAN/CGSB 19.13; and ASTM C920, Type S, Grade NS; mildew resistant, single component, colour white unless otherwise specified.
 - .1 Typical uses: Around washroom fixtures, lavatories, and other wet areas.
- .8 Preformed compressible and non-compressible back-up materials:
 - .1 Polyethylene, urethane, neoprene or vinyl foam:
 - .1 Extruded closed cell foam backer rod.
 - .2 Size: Oversize 30 to 50%.
 - .2 Neoprene or butyl rubber:
 - .1 Round solid rod, Shore A hardness 70.
 - .3 High density foam:
 - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.
 - .4 Bond breaker tape:
 - .1 Polyethylene bond breaker tape that will not bond to sealant.
- .9 Primer: As recommended by sealant manufacturer, where required, for adhesion of sealant to substrate.

2.3 JOINT CLEANER

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant in accordance with sealant manufacturer's written recommendations.
- .2 Primer: in accordance with sealant manufacturer's written recommendations.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for joint sealants installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 SURFACE PREPARATION

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter that may impair Work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime joint substrates as recommended by sealant manufacturer immediately prior to caulking.

3.4 BACKUP MATERIAL

- .1 Apply bond breaker tape where required, to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

- .1 Mix materials in accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- .1 Sealant:
 - .1 Mask edges of joint where irregular surface or sensitive joint border exists, to provide neat joint.
 - .2 Apply sealant in continuous beads.
 - .3 Apply sealant using gun with proper size nozzle.
 - .4 Use sufficient pressure to fill voids and joints solid.
 - .5 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .6 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - .7 Remove excess compound promptly as work progresses and upon completion.
- .2 Curing:
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.

- .2 Do not cover up sealants until proper curing has taken place.

3.7 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Clean adjacent surfaces immediately.
 - .3 Remove excess and droppings, using recommended cleaners as work progresses.
 - .4 Remove masking tape after initial set of sealant.
- .2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.8 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by joint sealant installation.

END OF SECTION

DOOR							FRAME				STC	UL	HDW SET	HARDWARE NOTES
NO.	NOMINAL SIZE (w x h)	TYPE	L	CORE	FINISH	GLASS	TYPE	L	FINISH	GLASS				
BASEMENT														
DB13	915 x 2150 (X2)	1	HM	-	PT	-	A	HM	PT	-	-	1HR	1	1
DB52	915 x 2150	1	HM	-	PT	-	A	HM	PT	-	-	1HR	2	
4TH FLOOR														
D475A	915 x 2150	2	HM	-	PT	GL-FP	A	HMI	PT	-	45	1HR	3	1
D475B	915 x 2150	2	HM	-	PT	GL	A	HMI	PT	-	45	-	3	1
D476C	915 x 2150	2	HM	-	PT	GL-FP	A	HMI	PT	-	45	1HR	3	1
D477	915 x 2150	1	WD	SC	ST	-	A	HM	PT	-	45	-	4	
D481	915 x 2150	2	WD	SC	ST	GL	A	HMI	PT	-	45	-	5	
D482	915 x 2150	1	WD	SC	ST	-	B	HMI	PT	GL	45	-	5	
D483	915 x 2650	1	HM	-	PT	-	A	HM	PT	-	-	1HR	6	1
D484	915 x 2150	1	WD	SC	ST	-	B	HMI	PT	GL	45	-	7	
D485	915 x 2150	1	WD	SC	ST	-	B	HMI	PT	GL	45	-	7	
D486	915 x 2150	1	WD	SC	ST	-	B	HMI	PT	GL	45	-	7	
D487A	915 x 2150	2	HM	-	PT	GL-FP	A	HM	PT	-	-	1HR	8	2
D487B	915 x 2150	2	HM	-	PT	GL-FP	A	HM	PT	-	-	1HR	8	2
D491	915 x 2150	1	WD	SC	ST	-	A	HM	PT	-	45	-	7	
D4115	915 x 2150	1	HM	-	PT	-	A	HM	PT	-	45	1HR	9	3

LEGEND

ST	STAIN FINISH	PS	PRESSED STEEL
EX	EXISTING	PT-#	PAINT - REFER TO ROOM FINISH SCHEDULE
GL	12MM TEMPERED GLASS	RE	REFINISH TO MATCH NEW DOORS
GL-FP	12MM FIRE RATED GLASS	HDW	HARDWARE
HM	HOLLOW METAL	ALUM	PRE-FINISHED ALUMINUM
HR	HOUR	UL	FIRE RATING
NR	NON-RATED FIRE SEPARATION	SC	SOLID CORE
NR	NON-RATED FIRE SEPARATION	STC	SOUND TRANSMISSION CLASS (Non-tested)
NIC	NOT IN CONTRACT	WD	WOOD

HARDWARE

1	CARD ACCESS
2	ADO BOTH SIDES
3	RE-USE EXISTING HARDWARE
4	
5	
6	

Note: Refer to Construction Plan (Sheet A4) for door and frame types)

Part 1 General

1.1 REFERENCES

- .1 American Architectural Manufacturers Association (AAMA)
 - .1 AAMA 812-04 (2010), Voluntary Practice for Assessment of Single Component Aerosol Expanding Polyurethane Foams for Sealing Rough Openings of Fenestration Installations.
- .2 ASTM International (ASTM)
 - .1 ASTM A653/A653M-08, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Canadian Standards Association (CSA)
 - .1 CSA W59-13, Welded Steel Construction (Metal Arc Welding).
- .5 Canadian Steel Door Manufacturers' Association (CSDMA)
 - .1 CSDMA, Recommended Specifications for Commercial Steel Doors and Frame Products, 2006.
 - .2 CSDMA, Recommended Selection and Usage Guide for Commercial Steel Door and Frame Products, 2009.
- .6 National Fire Protection Association (NFPA)
 - .1 NFPA 80-2007, Standard for Fire Doors and Other Opening Protectives.
 - .2 NFPA 252-12, Fire Tests of Door Assemblies.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN4-S104-M80, Standard Method for Fire Tests of Door Assemblies.
 - .2 CAN4-S105-M85, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC S104.

1.2 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Provide fire labelled frames for openings requiring fire protection ratings.
 - .2 Steel fire rated doors and frames: labelled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4-S104 or NFPA 252 for ratings specified or indicated.

1.3 SUBMITTALS

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

- .2 Shop drawings:
 - .1 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazing, arrangement of hardware, fire ratings, and finishes.
 - .2 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings, fire rating, and finishes.
 - .3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.

1.4 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: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Hot dipped galvanized steel sheet: To ASTM A653M, Z120 (G40), minimum base steel thickness in accordance with CSDMA Table 1 - Thickness for Component Parts.

2.2 DOOR CORE MATERIALS

- .1 Honeycomb construction: Structural small cell, 24.5 mm maximum kraft paper 'honeycomb', weight: 36.3 kg per ream minimum, density: 16.5 kg/m³ minimum, sanded to required thickness.

2.3 ADHESIVES

- .1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
- .2 Lock-seam doors: Fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 PRIMER

- .1 Touch-up primer to CAN/CGSB 1.181.

2.5 PAINT

- .1 Field paint steel doors and frames in accordance with Section 09 91 00 – Painting. Protect weather stripping from paint. Provide final finish free of scratches or other blemishes.

2.6 ACCESSORIES

- .1 Door Hardware and Weather Stripping: Specified in Section 08 71 00.
- .2 Door silencers: Single stud rubber/neoprene type.
- .3 Frame fill: To AAMA 812, low-pressure, minimal expansion single component polyurethane spray foam, closed cell.
- .4 Metallic paste filler: To manufacturer's standard.
- .5 Fire labels: Metal riveted.
- .6 Sealant: Refer to Section 07 92 00 – Joint Sealing.
- .7 Glazing Stops: Formed galvanized steel channel, minimum 16 mm high, accurately fitted, butted at corners and fastened to frame sections with counter-sunk, tamper proof sheet metal screws.
- .8 Glazing: Refer to Section 08 80 50 – Glazing.

2.7 FRAMES FABRICATION GENERAL

- .1 Fabricate frames in accordance with CSDMA specifications.
- .2 Fabricate frames to profiles and maximum face sizes as indicated.
- .3 Interior frames: 1.6 mm, welded construction.
- .4 Blank, reinforce, drill and tap frames for mortised, templated hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.
- .5 Frames in 'secure wall' installations: Reinforce frames with steel plate, 6.4 mm x 25 mm x 610 mm, tack welded on every edge. Align center of reinforcement plate with lock bolt.
- .6 Prepare frame for door silencers, 3 for single door, 2 at head for double door.
- .7 Manufacturer's nameplates on frames and screens are not permitted.
- .8 Conceal fastenings except where exposed fastenings are indicated.
- .9 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.

2.8 FRAME ANCHORAGE

- .1 Provide appropriate anchorage to floor and wall construction.
- .2 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.
- .3 Provide 2 anchors for rebate opening heights up to 1520 mm and 1 additional anchor for each additional 760 mm of height or fraction thereof.
- .4 Locate anchors for frames in existing openings not more than 150 mm from top and bottom of each jambs and intermediate at 660 mm on centre maximum.

2.9 FRAMES: WELDED TYPE

- .1 Welding in accordance with CSA W59.
- .2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
- .3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- .4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in 2 temporary jamb spreaders per frame to maintain proper alignment during shipment.

2.10 DOOR FABRICATION GENERAL

- .1 Doors: Swing type, flush, with provision for glass openings as indicated.
- .2 Form face sheets for interior doors from 1.3 mm sheet steel with honeycomb core laminated under pressure to face sheets.
- .3 Fabricate doors with longitudinal edges locked seamed, adhesive assisted.
 - .1 Seams: Visible.
- .4 Blank, reinforce, drill doors and tap for mortised, templated hardware, and electronic hardware.
- .5 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.
- .6 Reinforce doors where required, for surface mounted hardware. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- .7 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- .8 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in conformance with CAN/ULC S104 or NFPA 252 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION GENERAL

- .1 Install labelled steel fire rated doors and frames to NFPA 80 except where specified otherwise.
- .2 Install doors and frames to CSDMA Installation Guide.

3.3 FRAME INSTALLATION

- .1 Set frames plumb, square, level, and at correct elevation.
- .2 Secure anchorages and connections to adjacent construction.
- .3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- .4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- .5 Fill frame cavity fully with low-expanding polyurethane spray foam.
- .6 Caulk perimeter of frames between frame and adjacent material.

3.4 DOOR INSTALLATION

- .1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Door Hardware.
- .2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
 - .1 Hinge side: 1.0 mm.
 - .2 Latchside and head: 1.5 mm.
 - .3 Finished floor, top of carpet and thresholds: 13 mm.
- .3 Adjust operable parts for correct function.

3.5 FINISH REPAIRS

- .1 Touch up with primer finishes damaged during installation.
- .2 Fill exposed frame anchors with metallic paste filler and sand to a uniform smooth finish.

3.6 GLAZING

- .1 Install glazing for doors and frames in accordance with Section 08 80 50 - Glazing.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Architectural Woodwork Manufacturers Association of Canada (AWMAC)
 - .1 Architectural Woodwork Standards, Edition 2, 2014.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 71.19-M88, Adhesive, Contact, Sprayable.
 - .2 CAN/CGSB 71.20-M88, Adhesive, Contact, Brushable.
- .3 Canadian Standards Association (CSA)
 - .1 CSA A440.2-14, Fenestration Energy Performance.
 - .2 CSA O115-M1982 (R2001), Hardwood and Decorative Plywood.
 - .3 CAN/CSA O132.2 Series-90 (R1998), Wood Flush Doors.
 - .4 CAN/CSA O132.5-M1992 (R1998), Stile and Rail Wood Doors.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 80-2007, Standard for Fire Doors and Other Opening Protectives.
 - .2 NFPA 252-2012, Fire Tests of Door Assemblies.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN4-S104-M80, Fire Tests of Door Assemblies.
 - .2 CAN4-S105-M85, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC S104.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications, data sheets and installation instructions. Include door core materials, thickness, construction, and veneer species.
 - .2 Submit WHMIS Material Safety Data Sheets. Indicate VOC content for door materials and adhesives.
- .3 Shop Drawings:
 - .1 Indicate door types and cut-outs for lights, sizes, core construction, transom panel construction, locations, swings, undercuts, hardware locations and preparation requirements, blocking for hardware in mineral core doors, fire ratings, finishes, glass, and other pertinent data.
- .4 Samples:
 - .1 Submit pre-finished veneer sample illustrating colour of specified door faces.

- .5 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.3 REGULATORY REQUIREMENTS

- .1 Wood fire rated doors:
 - .1 Provide doors tested in compliance with CAN4-S104 or NFPA 252.
 - .2 Provide doors with ULC or ITS/Warnock Hersey label.
- .2 Installed Fire Rated Door Assembly: Conform to NFPA 80 for fire rated class as indicated.
- .3 Provide fire-rated wood doors with either ULC or ITS/Warnock Hersey label, and of the construction standard to the door manufacturer and conform to the requirements of manufacturer's labelling agency.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, protect, and handle products in compliance with AWMAC Architectural Woodwork Standards, and with manufacturer's recommendations.
- .2 Arrange for delivery after work causing abnormal humidity has been completed.
- .3 Accept doors on site in manufacturer's packaging. Inspect for damage.
- .4 Storage and Protection:
 - .1 Protect doors from dampness.
 - .2 Store doors in well ventilated room, off floor, in accordance with manufacturer's recommendations.
 - .3 Protect doors from scratches, handling marks, and other damage.
 - .4 Store doors away from direct sunlight.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Ensure products contain no added urea formaldehyde resins and adhesives.

2.2 FIRE RATED WOOD DOORS

- .1 Tested in accordance with CAN4-S104 or NFPA 252 to achieve rating as scheduled.
- .2 Solid core: To CAN/CSA O132.2, stile and rail frame, 5-ply construction.
 - .1 Core for 60 minute rated doors: Mineral.

- .3 Stiles and rails: Manufacturer's standard, conforming to requirements of manufacturer's labelling agency.
- .4 Face Panels:
 - .1 Hardwood; Premium, Grade A Maple.
 - .2 Faces intended for transparent finish: Quarter Cut.
- .5 Edges: Square, AWMAC Type A, solid wood, same species as veneer face.
- .6 Adhesive: Type II (water resistant) for interior doors.

2.3 NON-RATED WOOD FLUSH DOORS

- .1 Manufacture doors to ANSI/WDMA I.S. 1a-11 Heavy Duty performance level.
- .2 Solid core: To CAN/CSA O132.2, stile and rail frame, 5-ply construction.
 - .1 Particleboard or structural composite lumber.
- .3 Face Panels:
 - .1 Hardwood; Premium, Grade A Maple.
 - .2 Faces intended for transparent finish: Quarter Cut.
- .4 Edges: Square, AWMAC Type A, solid wood, same species as veneer face.
- .5 Adhesive: Type II (water resistant) for interior doors.

2.4 GLAZING

- .1 Glass: Refer to Section 08 80 50 – Glazing.

2.5 FABRICATION

- .1 Fabricate doors in accordance with AWMAC Custom grade.
- .2 Prepare doors for glazing. Provide glazing stops with mitred corners.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 INSTALLATION

- .1 Unwrap and protect doors in accordance with CAN/CSA O132.2 Series.
- .2 Install labelled fire rated doors to NFPA 80.
- .3 Install doors and hardware in accordance with manufacturer's printed instructions and CAN/CSA O132.2 Series.
- .4 Adjust hardware for correct function.

- .5 Install glazing in accordance with Section 08 80 50 - Glazing.
- .6 Install stops.

3.3 ADJUSTMENT

- .1 Re-adjust doors and hardware just prior to completion of building to function freely and properly.

3.4 CLEANING

- .1 Perform cleaning as soon as possible after installation to remove construction and accumulated environmental dirt.
- .2 Remove traces of primer and caulking; clean doors and frames.
- .3 Clean glass and glazing materials with approved non-abrasive cleaner.
- .4 On completion of installation, remove surplus materials, rubbish, tools, and equipment barriers.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 80-2013, Fire Doors and Other Opening Protectives.
- .2 Underwriters Laboratory of Canada (ULC)
 - .1 CAN/ULC S104-10, Fire Tests of Door Assemblies.

1.2 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 access door components; include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Shop Drawings: Submit catalogue details for each type of door illustrating profiles, dimensions, and methods of assembly. Indicate location and details of installation.

1.3 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: Submit operation and maintenance data for incorporation into O&M manual.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Coordinate placement of access panels with mechanical, electrical, and plumbing trades.
- .2 Confirm placement of access panels with Departmental Representative before installation.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect access doors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 ACCESS PANELS

- .1 Components:
 - .1 Frame: Steel sheet, galvanized, minimum 1.6 mm (16 gauge) thick, with flange for installation to gypsum board substrate and rounded safety corners.
 - .1 Weld exposed joints in flange and grind smooth.
 - .2 Door: Steel sheet, galvanized, minimum 1.6 mm thick, reinforced to maintain flat surface.
 - .3 Hinge: Continuous steel with pin hinge or concealed, spring hinge, with 175° swing.
 - .4 Lock: Flush, screwdriver operated cam lock.
 - .5 Finish: Powder coat prime paint.
 - .6 Rated access panels: For fire rated wall assemblies, provide access panels complying NFPA 80 or CAN/ULC S104, with insulated sandwich-type construction.
 - .1 Fire rating of hatch: To meet that of wall or ceiling assembly to which panel is installed.
- .2 Fabrication:
 - .1 Fabricate components straight, square, and flat, with slightly rounded exposed edges.
 - .2 Ensure products are without burrs, snags, and sharp edges.
 - .3 Exposed welds continuous and ground smooth.
 - .4 Provide anchors or make provisions in frame for anchorage to adjacent construction. Provide size, number, and location of anchors on all sides to secure access panel in opening.
- .3 Sizes: As follows, unless indicated otherwise in Drawings:
 - .1 For body entry: 750 x 750 mm minimum.
 - .2 For hand entry: 300 x 300 mm minimum.

2.2 FINISH

- .1 Refer to Section 09 91 00 – Painting.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for access panel installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.

- .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Follow manufacturer's instructions for installation of access panels.
- .2 Locate access doors within view of equipment and ensure equipment is accessible for operating, inspecting, adjusting, servicing without using special tools.
- .3 Install panels level, plumb, and straight.

3.3 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Final Cleaning: Upon completion, remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by access door installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI A115.1, Specifications for Steel Door and Frame Preparation.
 - .2 ANSI/BHMA A117.1-2009, Standard for Accessible and Usable Buildings.
 - .3 ANSI/BHMA A156.1-2013, American National Standard for Butts and Hinges.
 - .4 ANSI/BHMA A156.3-2014, Exit Devices.
 - .5 ANSI/BHMA A156.4-2013, Door Controls - Closers.
 - .6 ANSI/BHMA A156.6-2015, Architectural Door Trim.
 - .7 ANSI/BHMA A156.8-2015, Door Controls – Overhead Stops and Holders.
 - .8 ANSI/BHMA A156.13-2012, Mortise Locks.
 - .9 ANSI/BHMA A156.16-2013, Auxiliary Hardware.
 - .10 ANSI/BHMA A156.19-2013, Power Assist and Low Energy Power Operated Doors.
 - .11 ANSI/BHMA A156.22-2012, Door Gasketing and Edge Seal Systems.
 - .12 ANSI/BHMA A156.31-2013, Electric Strikes and Frame Mounted Actuators.
- .2 ASTM International
 - .1 ASTM E283-04 (2012), Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .2 ASTM F1577-05 (2012), Standard Test Methods for Detention Locks for Swinging Doors.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B651-12 – Accessible Design for the Built Environment.
- .4 Canadian Steel Door and Frame Manufacturers' Association (CSDMA)
 - .1 CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames - 2009.
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA 105-2016, Smoke Door Assemblies and Other Opening Protectives.
- .6 Underwriters Laboratories
 - .1 UL 1034, Burglary-Resistant Electric Locking Mechanisms.
- .7 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC S104-10, Fire Tests of Door Assemblies.

1.2 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 door hardware and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.
 - .4 After approval samples will be returned for incorporation in Work.
- .4 Hardware List:
 - .1 Submit contract hardware list.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.
- .5 Manufacturer's Instructions: Submit manufacturer's installation instructions.
- .6 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

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 door hardware for incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Hardware for doors in fire separations and exit doors certified by a Canadian Certification Organization accredited by Standards Council of Canada.

1.5 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 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Package items of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.

- .4 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, well-ventilated area.
 - .2 Store and protect door hardware from nicks, scratches, and blemishes.
 - .3 Protect prefinished surfaces with wrapping or strippable coating.
 - .4 Replace defective or damaged materials with new.

Part 2 Products

2.1 HARDWARE ITEMS

- .1 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

- .1 Mortise locks and latches: To BHMA A156.13, series 1000 mortise lock, Grade 1 and Security Grade 1. Meets impact requirements of ASTM F1577.
 - .1 Case: Wrought steel, zinc dichromate plated, 3 mm thick.
 - .2 Latchbolt: Stainless steel, minimum 19 mm throw.
 - .3 Strikes: To ANSI A115.1, curved lip.
 - .4 Lever: L-shaped, forged or cast.
 - .5 Rose: Round, heavy wrought.
 - .6 Function: As scheduled.
- .2 Electric mortise locks: To BHMA A156.13, Grade 1, fail-safe operation, UL listed for fire doors.
 - .1 12-24 V capable.
 - .2 Latchbolt: Stainless steel, anti-friction, minimum 19 mm throw.
 - .3 Strikes: To ANSI A115.1, curved lip.
 - .4 Lever: L-shaped, forged or cast.
 - .5 Rose: Round, heavy wrought.
- .3 Rim exit devices: To BHMA A156.3, Grade 1; UL listed for fire exits; cast chassis with non-ferrous removable cover; complete with polycarbonate push pad and end caps.
- .4 Electric strikes: To BHMA A156.31, Grade 1; heavy duty stainless steel.
 - .1 Conforms to CAN/ULC-S104 for fire doors.
 - .2 Static strength: 660 kg (1500 lbs)
 - .3 Dynamic strength: 95 N-m (70 ft-lbs).
 - .4 UL 1034 – burglar resistant, suitable for outdoor use.
 - .5 Dual voltage: 12/24 V.
- .5 Hinges: To BHMA A156.1, five-knuckle, standard weight, 0.134 gauge steel.
 - .1 Provide hinges with non-removable pins where scheduled.

- .2 Provide pre-wired hinges where scheduled.
- .6 Door closers: To BHMA A156.4, Grade 1, and ANSI A117.1, rack and pinion operation, aluminum case, adjustable backcheck intensity.
 - .1 Arms for regular duty: Manufacturer's standard.
 - .2 Arms for heavy duty application: Heavy duty forged steel.
- .7 Door bottom: To ANSI/BHMA A156.22 and ASTM E283, aluminum case with movable sponge neoprene drop bar seal. Seal actuated by plunger contacting jamb.
 - .1 Mounting: Semi-mortised or full mortised, as scheduled.
- .8 Overhead stop: To BHMA A156.8, Grade 1 and 2; low-profile, concealed mounting; UL listed for fire doors.
- .9 Door operators: Power assist and low energy power operators: To BHMA A156.19, rack and pinion design contained within cast aluminum housing, 170° swing.
 - .1 Actuator: Push-plate style, 900 x 150 mm press area, stainless steel face plate, hardwired.
- .10 Wall stops: Brass, bronze, and stainless steel with rubber bumper, 63 mm diameter, 19 mm projection, concealed mounting.
 - .1 Bumper: Convex.
- .11 Flush bolts: To BHMA A156.16, Type 27; automatic operation, brass and stainless steel.
 - .1 Dust proof strike: Brass; compatible with flush bolt; adjustable height, barrel 22 mm (7/8 inch) diameter x 51 mm (2 inches) depth.
 - .2 Coordinator: To ANSI A156.3 Type 21A, with override protection feature; complete with filler bar.
- .12 Adhesive gasketing: Silicone extrusion, compression bulb style, with stabilizer flange, and adhesive backing; meets NFPA 105.
- .13 Adjustable gasketing: Extruded tempered aluminum retainer, alloy 6063-T6; with silicone seal, stainless steel fasteners.
- .14 Architectural door trim: To BHMA A156.6.
 - .1 Door protection plates: Kick plate type 1.27 mm thick stainless steel, No. 4 finish.

2.3 FASTENINGS

- .1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.
- .2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
- .3 Exposed fastening devices to match finish of hardware.

- .4 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.
- .5 Use fasteners compatible with material through which they pass.

2.4 KEYING

- .1 Coordinate with Departmental Representative for Keying Strategy.
- .2 Provide keys in duplicate for every lock.
- .3 Provide four master keys for each master key group.
- .4 Stamp keying code numbers on keys and cylinders.

Part 3 Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Supply door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Supply manufacturers' instructions for proper installation of each hardware component.
- .4 Install hardware to standard hardware location dimensions in accordance with CSDFMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction) and CSA B651.
- .5 Use only manufacturer's supplied fasteners.
 - .1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.

3.2 ADJUSTING

- .1 Adjust door hardware, operators, closures, and controls for optimum, smooth operating condition and safety.
- .2 Lubricate hardware, operating equipment, and other moving parts.
- .3 Adjust door hardware to ensure tight fit at contact points with frames.

3.3 CLEANING

- .1 Progress Cleaning: In accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
 - .3 Remove protective material from hardware items where present.

- .4 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by door hardware installation.

3.5 SCHEDULE

Set: 1.0

7 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Hinge	TA2714 QC12 4-1/2" x 4"	US26D	MK
1 Flush Bolt Set	2845	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Fail Secure Electric Lock	RX 8271-24V LNL	US26D	SA
1 Cylinder to Suit	By Owner		
1 Coordinator	2600 Series x Filler	Black	RO
2 Conc Overhead Stop	2-X36	630	RF
2 Door Closer	1431 O	EN	SA
2 Kick Plate	K1050 10"	US32D	RO
1 Gasketing	S88BL		PE
2 Door Bottom	4131CRL		PE
1 Astragal	By Door Supplier		
1 ElectroLynx Harness	QC-C1500P		MK
1 ElectroLynx Harness	QC-C400		MK
1 Card Reader	By Security Division		
1 Power Supply	By Electrical Division		

Set: 2.0

3 Hinge	TA2714 NRP 4-1/2" x 4"	US26D	MK
1 Passage Set	8215 LNL	US26D	SA
1 Door Closer	1431 PS	EN	SA
1 Kick Plate	K1050 10"	US32D	RO
1 Gasketing	S88BL		PE
1 Door Bottom	4131CRL		PE

Set: 3.0

1 Hinge	TA2714 QC12 4-1/2" x 4"	US26D	MK
2 Hinge	TA2714 NRP 4-1/2" x 4"	US26D	MK
1 Fail Secure Electric Lock	RX 8271-24V LNL	US26D	SA
1 Cylinder to Suit	By Owner		
1 Door Closer	1431 O	EN	SA
1 Kick Plate	K1050 10"	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Gasketing	379CS		PE
1 Door Bottom	420APKL		PE
1 ElectroLynx Harness	QC-C1500P		MK
1 ElectroLynx Harness	QC-C300		MK
1 Card Reader	By Security Division		
1 Power Supply	By Electrical Division		

Set: 4.0

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Passage Set	8215 LNL	US26D	SA
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Gasketing	379CS		PE
1 Door Bottom	420APKL		PE

Set: 5.0

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Passage Set	8215 LNL	US26D	SA
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Gasketing	379CS		PE
1 Door Bottom	420APKL		PE

Set: 6.0

1 Hinge	TA2714 QC12 4-1/2" x 4"	US26D	MK
3 Hinge	TA2714 NRP 4-1/2" x 4"	US26D	MK

1 Fail Secure Electric Lock	RX 8271-24V LNL	US26D	SA
1 Cylinder to Suit	By Owner		
1 Door Closer	1431 O	EN	SA
1 Kick Plate	K1050 10"	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Door Bottom	420APKL		PE
1 ElectroLynx Harness	QC-C1500P		MK
1 ElectroLynx Harness	QC-C400		MK
1 Card Reader	By Security Division		
1 Power Supply	By Electrical Division		

Set: 7.0

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Office Lock	8205 LNL	US26D	SA
1 Cylinder to Suit	By Owner		
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Gasketing	379CS		PE
1 Door Bottom	4131CRL		PE

Set: 8.0

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Rim Exit Device	12 8815 ETL	US32D	SA
1 Electric Strike	9500	630	HS
1 Automatic Operator	5730	689	NO
1 Kick Plate	K1050 10"	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Door Bottom	420APKL		PE
2 Full Height Actuator	639		NO

Notes: Free egress and access at all times. Pushing full height actuator on either side of door will release the electric strike and power open the door. Electric strike can be powered by the auto operator's on board power supply.

Set: 9.0

Re-use Relocated Hardware

Notes: Salvage hardware from existing door and re-use at this location. Re-use door if possible.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI Z97.1-2015, Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.
- .2 ASTM International
 - .1 ASTM C542-05 (2011), Standard Specification for Lock-Strip Gaskets.
 - .2 ASTM D1929-14, Standard Test Method for Determining Ignition Temperature of Plastics.
 - .3 ASTM D2240-05 (2010), Standard Test Method for Rubber Property - Durometer Hardness.
 - .4 ASTM F1233-08 (2013), Standard Test Method for Security Glazing Materials and Systems.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 12.1-2017, Safety Glazing.
 - .2 CAN/CGSB 12.8-97, Insulating Glass Units.
- .4 Glass Association of North American (GANA)
 - .1 GANA Glazing Manual – current edition.
 - .2 GANA Laminated Glazing Reference Manual - 2009.
- .5 United States Consumer Product Safety Commission (CPSC)
 - .1 CPSC 16CFR1201 – Safety Standard for Architectural Glazing Materials.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Hold project meetings bi-weekly.
- .2 Ensure key personnel, site supervisor, project manager, and subcontractor representatives attend.
- .3 Departmental Representative will submit written notification of change to meeting schedule established upon contract award 24 hours prior to scheduled meeting.

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for glass, sealants, and glazing accessories; include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

- .1 Show layout, profiles, and product components, including anchorage, accessories, finishes, colours, patterns.
- .2 Include detailed plans, elevations, details of framing members, sealants, fasteners, anchors, thicknesses.
- .4 Samples:
 - .1 Submit duplicate 200 x 200 mm size samples of each type of glass proposed for installation.
- .5 Certificates: Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

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 glazing for incorporation into manual.

1.5 QUALITY ASSURANCE

- .1 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct mock-up to include glass and glazing.
 - .3 Mock-up will be used:
 - .1 To judge quality of work, substrate preparation, operation of equipment and material application.
 - .4 Locate where directed by Departmental Representative.
 - .5 Allow 24 hours for inspection of mock-up before proceeding with work.
 - .6 Reviewed mock-up may remain as part of finished work.

1.6 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 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 glazing and frames from nicks, scratches, and blemishes.

- .3 Protect prefinished aluminum surfaces with strippable coating.
- .4 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Safety glass for doors: To CAN/CGSB 12.1, transparent, 12 mm thick.
 - .1 Type 2-tempered.
 - .2 Class B-float.
 - .3 Category 11.
 - .4 Edge treatment.
- .2 Wired fire-rated glass for doors: To CAN/CGSB 12.1-2017, laminated wired glass, 12 mm thick.
 - .1 Fire rating: UL classified and labelled.
 - .2 Impact safety rating: ANSI Z97.1 and CPSC 16CFR1201 CAT I and II.
 - .3 Provide glazing tapes recommended by wired glass manufacturer for compliant fire-rated installation.
- .3 Glass for side lights and transoms: To CAN/CGSB 12.8, dual glazed units.
 - .1 Pane 1: 13 mm tempered and laminated pane with acoustic interlayer.
 - .2 Air space: 25 mm.
 - .3 Pane 2: 10 mm tempered pane; set in silicon channel; with 18 gauge, 38 mm perforated steel stop packed with insulation.

2.2 ACCESSORIES

- .1 Setting blocks: Neoprene, 80-90 Shore A durometer hardness to ASTM D2240, to suit glazing method, glass light weight and area.
- .2 Spacer shims: Neoprene, 50-60 Shore A durometer hardness to ASTM D2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self-adhesive on one face.
- .3 Glazing tape: Preformed butyl compound with integral resilient tube spacer, 10-15 Shore A durometer hardness to ASTM D2240; coiled on release paper; widths as required for application, black colour.
- .4 Glazing splines: Resilient polyvinyl chloride or silicone, extruded shape to suit glazing channel retaining slot, colour as selected by Departmental Representative.
- .5 Lock-strip gaskets: To ASTM C542.
- .6 Sealant: In accordance with Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for glazing installation in accordance with manufacturer's written instructions.
 - .1 Verify openings for glazing are correctly sized and within tolerance.
 - .2 Verify surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
 - .3 Visually inspect substrate.
 - .4 Inform Departmental Representative of unacceptable conditions.
 - .5 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

- .1 Clean contact surfaces with solvent and wipe dry.
- .2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .3 Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION: INTERIOR - DRY METHOD (TAPE AND TAPE)

- .1 Perform work in accordance with GANA Glazing Manual and [GANA Laminated Glazing Reference Manual] for [glazing installation methods].
- .2 Cut glazing tape to length and set against permanent stops, projecting 1.6 mm above sight line. Butt-joint tape edges, seal joints with butyl sealant.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Set glass unit on setting blocks; apply pressure against fixed stop for full contact.
- .5 Place glazing tape on free perimeter of glazing in same manner described.
- .6 Install removable stop without displacement of tape. Apply pressure on tape for full continuous contact.
- .7 Knife trim protruding tape.

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.
 - .1 Remove traces of primer, caulking.
 - .2 Remove glazing materials from finish surfaces.
 - .3 Remove labels.
 - .4 Clean glass using approved non-abrasive cleaner in accordance with manufacturer's instructions.

- .2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 After installation, mark each light with an "X" by using removable plastic tape or paste.
- .3 Repair damage to adjacent materials caused by glazing installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C475/C475M-15, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .2 ASTM C557-03 (2009)e1, Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - .3 ASTM C645-14, Non-Structural Steel Framing Members.
 - .4 ASTM C754-15, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - .5 ASTM C840-13, Standard Specification for Application and Finishing of Gypsum Board.
 - .6 ASTM C1002-14, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .7 ASTM C1047-14a, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .8 ASTM C1396/C1396M-06a, Standard Specification for Gypsum Wallboard.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .3 Expanded Metal Mesh Association (EMMA)
 - .1 EMMA 557-15, Standards for Expanded Metal.
- .4 Gypsum Association (GA)
 - .1 GA-214-15, Recommended Levels of Finish for Gypsum Board, Glass Mat, and Fiber-Reinforced Gypsum Panels.
 - .2 GA-216-13, Application and Finishing of Gypsum Panel Products.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S101-07, Standard Method of Fire Endurance Tests of Building Construction and Materials.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies; include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 REGULATORY REQUIREMENTS

- .1 Conform to applicable code for fire rated assemblies in conjunction with Section 09 22 16 as follows:
 - .1 Fire resistance classifications to CAN/ULC S101.
 - .2 Fire rated Design Assembly No. as listed on Drawings.

1.4 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 Deliver materials to site in original packaging, labelled with manufacturer's name and identification.
- .3 Storage and Handling Requirements:
 - .1 Store gypsum board assemblies materials level off ground and indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.
 - .3 Protect from weather, elements and damage from construction operations.
 - .4 Handle gypsum boards to prevent damage to edges, ends or surfaces.
 - .5 Replace defective or damaged materials with new.

1.5 AMBIENT CONDITIONS

- .1 Maintain temperature 10°C minimum, 21°C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.
- .2 Apply board and joint treatment to dry, frost-free surfaces.
- .3 Ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 Products

2.1 MATERIALS

- .1 Standard gypsum board: ASTM C1396/C1396M, regular and Type X, thickness as shown on Drawings, 1200 mm wide x maximum practical length, ends square cut, edges square.
- .2 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .3 Steel drill screws: ASTM C1002.
- .4 Laminating compound: As recommended by manufacturer, asbestos-free.

- .5 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, metal, zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one piece length per location.
- .6 Plenum barrier: Purpose made, bonded acoustical cotton, mineral wool fibre, or fibreglass, adhered to foil backing; 25 mm minimum thickness; to ASTM E84, Class A, flame spread ≤ 5 , smoke developed ≤ 35 .
- .7 Sealants: In accordance with Section 07 92 00 - Joint Sealants.
 - .1 Acoustic sealant: In accordance with Section 07 92 00 - Joint Sealants.
- .8 Polyethylene: CAN/CGSB 51.34, Type 2.
- .9 Joint tape: ASTM C475, 52 mm wide fibre paper tape.
- .10 Joint compound: ASTM C475, asbestos-free.

2.2 FRAMING MATERIALS

- .1 Studs and Tracks: As specified in Section 09 22 16.
- .2 Furring, framing, and accessories: ASTM C645.
- .3 Anchorage to substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application, and to rigidly secure materials in place.
 - .1 Tie wire: To ASTM C754.
 - .2 Hangers: To ASTM C754, galvanized.

2.3 STEEL MESH

- .1 To EMMA 557, flattened stainless steel mesh, style ¾-9F:
 - .1 Strand thickness: 3.05 mm (0.120 inch).
 - .2 Strand width: 4.2 mm (0.165 inch).
 - .3 Diamond opening: 14.3 x 42.9 mm (0.563 x 1.688 inch).
 - .4 Attachment: 4.8 mm (3/16 inch) steel pop rivets with 38 mm OD x 4.8 mm ID (1-1/2 inch OD x 3/16 inch ID) stainless steel fender washers, installed at 200 mm on centre.

2.4 SECURITY SLEEVES FOR DUCTS WITH FIRE DAMPERS

- .1 Angle frame: Steel, 3 mm thick, L-profile, 35 x 35 mm, mitred corners, fully welded.
- .2 Sleeve frame: Steel, 5 mm thick, dimensions to allow sleeve to fit over duct.
- .3 Bars: Horizontal and vertical, steel, 9.5 mm diameter, welded to frame at 150 mm on center.
- .4 Fasteners: Steel, 6 mm diameter bolts with matching hex nuts, at 200 mm on center around outside duct sleeve.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for installation of gypsum board assemblies in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 ERECTION

- .1 Apply and finish gypsum board to ASTM C840 or GA-216 except where specified otherwise.
- .2 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, and grilles.
- .3 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .4 Furr above suspended ceilings for gypsum board fire and sound stops, and to form plenum areas as indicated.
- .5 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.
- .6 Install furring as required for fire resistance ratings indicated.
- .7 Furr openings and around built-in equipment, cabinets, and access panels on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .8 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

- .1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical work, and mechanical work have been approved.
- .2 Apply single layer standard gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- .3 Double layer gypsum board:
 - .1 Base layer application:
 - .1 Apply gypsum board with long dimension parallel to studs.
 - .2 Position board with abutting edges located in centre of stud flanges.
 - .3 Stagger joints on opposite sides of partition so that joints occur on different studs.
 - .4 Screw-fasten base layer gypsum board to steel studs with 25 mm screws.

- .2 Face layer application:
 - .1 Apply gypsum board with long dimension parallel to studs.
 - .2 Position board with abutting edges located in centre of stud flanges.
 - .3 Stagger joints from base layer joints, and on opposite sides of the partition.
 - .4 Screw-fasten face layer to steel studs with screws that are minimum 10 mm longer than the total thickness of the material being attached to the studs.
- .4 Install fire rated gypsum board in accordance with applicable ULC design number.
- .5 Apply board using laminating adhesive on base layer of gypsum board.
- .6 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .7 Install gypsum board with face side out.
- .8 Do not install damaged or damp boards.
- .9 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION - GENERAL

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Construct control joints of preformed units set in gypsum board facing and supported independently on both sides of joint.
- .6 Provide continuous polyethylene dust barrier behind and across control joints.
- .7 Locate control joints at approximate 9 m spacing on long corridor runs.
 - .1 Place control joints consistent with lines of building spaces as indicated.
 - .2 Install control joints straight and true.
- .8 Construct expansion joints, at building expansion and construction joints. Provide continuous dust barrier.
 - .1 Install expansion joints straight and true.
- .9 Splice corners and intersections together and secure to each member with 3 screws.

- .10 Install access doors to electrical and mechanical fixtures as specified in their respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .11 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape, and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .12 Place corner beads at external corners.
 - .1 Use longest practical length.
 - .2 Place edge trim where gypsum board abuts dissimilar materials [and as indicated].
- .13 Finish gypsum board walls and ceilings to following levels in accordance with GA-214:
 - .1 Concealed areas:
 - .1 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable.
 - .2 Exposed areas:
 - .1 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.
- .14 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .15 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .16 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .17 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
- .18 Treat cut edges and holes in moisture resistant gypsum board with sealant.

3.5 ACOUSTIC ACCESSORIES INSTALLATION

- .1 Install resilient channels at maximum 600 mm on centre. Locate joints over framing members.
- .2 Place acoustic insulation in partitions tight within spaces, around cut openings, behind and around electrical and mechanical items within or behind partitions, and tight to items passing through partitions.
- .3 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions

abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, and in partitions where perimeter sealed with acoustic sealant.

- .4 Apply two 12 mm beads of acoustic sealant to bottoms of floor tracks and tops of ceiling tracks.

3.6 CEILING INSTALLATION

- .1 Install to ASTM C754 or GA-216.
- .2 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.
- .3 Install ceiling framing independent of walls, columns, and above ceiling work.
- .4 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .5 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .6 Install work level, to tolerance of 1:1200.
- .7 Coordinate location of hangers with other work.
- .8 Reinforce openings in ceiling suspension system that interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 600 mm past each end of openings.
- .9 Laterally brace entire suspension system.
- .10 Locate control joints as indicated in drawings.
 - .1 If additional control joints are required, locations to be approved by Departmental Representative prior to installation.

3.7 STEEL MESH INSTALLATION

- .1 Install mesh on 'attack' side of room.
- .2 Support edges with anti-spread bracing, studs, or corners.
- .3 Align sheet edges at all vertical and horizontal seams on centre line of steel stud or anti-spread bracing. Secure sheets with specified rivets installed at 200 mm on centre.
- .4 Screws are not acceptable for permanent attachment of security mesh.

3.8 TOLERANCES

- .1 Maximum variation of finished gypsum board surface from true flatness: 3 mm in 3 m, in any direction.

3.9 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning. 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 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.10 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by installation of gypsum board assemblies.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C645-14, Standard Specification for Nonstructural Steel Framing Members.
 - .2 ASTM C754-11, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Zinc-Rich Coating.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 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 metal framing. Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit duplicate 300 mm long samples of non-structural metal framing.

1.3 QUALITY ASSURANCE

- .1 Certificates: Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 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 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 metal framing from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Non-load bearing channel stud framing: To ASTM C645, stud size as shown on drawings, roll formed from hot dipped galvanized steel sheet, for screw attachment of gypsum board.
 - .1 Base steel thickness for studs and tracks unless otherwise indicated in drawings:
 - .1 General wall construction: Minimum 0.46 mm.
 - .2 Secure wall installations: Minimum 1.14 mm.
 - .2 Knock-out service holes at 460 mm centres.
 - .3 Floor and ceiling tracks: In widths to suit stud sizes.
 - .1 General wall construction: 32 mm flange height.
 - .2 Secure wall installations: 51 mm flange height.
- .2 Acoustical sealant: In accordance with Section 07 92 00 - Joint Sealants.
- .3 Touch-up primer for galvanized surfaces: CAN/CGSB 1.181.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate are acceptable for non-structural metal framing application in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 ERECTION

- .1 Align partition tracks at floor and ceiling and attach to slabs using expanding mechanical fasteners with spacing as follows:
 - .1 General wall construction: Maximum 600 mm on center.
 - .2 Secure wall construction: Maximum 300 mm on center.
- .2 Place studs vertically at spacing as indicated, not more than 50 mm from abutting walls, and at each side of openings and corners.
 - .1 Position studs in tracks at floor and ceiling. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.
- .3 Erect metal studding to tolerance of 1:1000.
- .4 Attach studs to bottom track using:
 - .1 General wall construction: Screws.

- .2 Secure wall construction: Rivets.
- .5 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .6 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .7 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified, at door frame openings, and at corners.
 - .1 Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .8 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs.
 - .1 Secure track to studs at each end, in accordance with manufacturer's instructions.
 - .2 Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .9 Install anti-spread bracing on both sides of door frames at 1200 mm from bottom of wall, between door frame double-studs and adjacent studs.
- .10 Frame openings and around built-in equipment, cabinets, access panels, and duct security sleeves. Frame on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .11 Provide wood blocking for attachment of fixtures behind lavatory basins, toilet and bathroom accessories attached to steel stud partitions. Refer to Section 06 10 00 – Rough Carpentry.
- .12 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .13 Extend partitions to ceiling height except where indicated otherwise.
- .14 Install two continuous 12 mm beads of acoustical sealant under studs and tracks around perimeter of sound control partitions.

3.3 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.4 PROTECTION

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

- .2 Repair damage to adjacent materials caused by non-structural metal framing application.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI A108/A118/A136.1-2014, Specifications for the Installation of Ceramic Tile.
 - .2 ANSI A137.1-2012, American National Standard Specifications for Ceramic Tile.
 - .3 ANSI A137.2-2013, American National Standard Specifications for Glass Tile.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 71-GP-22M, Adhesive, Organic, for Installation of Ceramic Wall Tile.
 - .2 CAN/CGSB 75.1-M88, Tile, Ceramic.
- .3 Terrazzo Tile and Marble Association of Canada (TTMAC)
 - .1 Tile Specification Guide 09 30 00, Tile Installation Manual 2016-2017.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data:
 - .1 Include manufacturer's information on:
 - .1 Tile, marked to show each type, size, and shape required.
 - .2 Finishing strip.
 - .3 Latex cement mortar and grout.
- .3 Samples:
 - .1 Tile: Submit duplicate, full-sized samples of each colour, texture, size, and pattern of tile proposed for installation.

1.3 QUALITY ASSURANCE

- .1 Conform to TTMAC Tile Installation Manual.

1.4 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: Remove waste material in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 AMBIENT CONDITIONS

- .1 Maintain air temperature and structural base temperature at ceramic tile installation area above 12°C for 48 hours before, during, and 48 hours after, installation.
- .2 Do not install tiles at temperatures less than 12°C or above 38°C.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide extra 5% of installed area each type and colour of tile installed to project, for maintenance use. Store where directed.
 - .3 Maintenance material to be from same production run as installed material.

Part 2 Products

2.1 TILE

- .1 Ceramic tile to ANSI A137.1 or glass tile to ANSI A137.2.
 - .1 Dimensions: Nominal 50-70 mm x 200-350 mm.
 - .2 Colour: As selected by Departmental Representative.

2.2 SURFACE PREPARATION MATERIALS

- .1 Primer: Low VOC, low viscosity primer as recommended by manufacturer to suit substrate and site conditions; provide proof of bonding ability of setting system where manufacturer recommends that primer is not necessary to installation.

2.3 BOND COAT

- .1 Ceramic tile:
 - .1 Thin-set interior installation: To ANSI A118.4, polymer-modified Portland cement, sanded.
- .2 Glass tile:
 - .1 Thin-set interior installation: Polymer modified mortar, non-sag, bright white, unsanded, meeting shear bond strength requirements of ANSI A118.4.

2.4 GROUT

- .1 To ANSI A118.6 and ANSI A118.7, premium polymer-modified Portland cement-based grout, unsanded, mould and mildew resistant.
 - .1 Flexural strength, 7 day: Minimum 6.9 MPa.
 - .2 Compressive strength: Minimum 20.7 MPa.

- .3 Shrinkage, 7 day: Maximum 0.2%.

2.5 ACCESSORIES

- .1 Finishing strips: Extruded Type 304 brushed stainless steel, profile with square visible surface, integrated perforated anchoring leg, and integrated grout joint spacer; brushed finish. Provide with matching inside and outside corners.
- .2 Sealant: In accordance with Section 07 92 00 - Joint Sealants.

2.6 CLEANING COMPOUNDS

- .1 Specifically designed for cleaning masonry and concrete and which will not prevent bond of subsequent tile setting materials including patching and levelling compounds and elastomeric waterproofing membrane and coat.
- .2 Materials containing acid or caustic material are not acceptable.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with TTMAC 304W-2016-2017.
- .2 Apply tile to clean and sound surfaces.
- .3 Fit tile around corners, fitments, fixtures, drains and other built-in objects. Maintain uniform joint appearance. Cut edges smooth and even. Do not split tiles.
- .4 Maximum surface tolerance 1:800.
- .5 Knock down trowel ridges and back butter glass tile to ensure ridges are not visible through installed tile.
- .6 Make joints between tile uniform and approximately 1.5 mm wide, plumb, straight, true, even and flush with adjacent tile. Ensure sheet layout not visible after installation. Align patterns.
- .7 Remove excess mortar from tile joint areas so at least 2/3 of the tile depth remains for grouting.
- .8 Lay out tiles so perimeter tiles are minimum 1/2 size.
- .9 Sound tiles after setting and replace hollow-sounding units to obtain full bond.
- .10 Use round edged tiles at termination of wall tile panels, except where panel abuts projecting surface or differing plane.
- .11 Allow minimum 24 hours after installation of tiles, before grouting.

- .12 Clean installed tile surfaces after installation and grouting cured.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A641/A641M-09a (2014) – Standard Specification for Zinc-Coated/Galvanized Carbon Steel Wire.
 - .2 ASTM C423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM C635/C635M-13a, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
 - .4 ASTM C636/C636M-13, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - .5 ASTM E1110-06 (2011), Standard Classification for Determination of Articulation Class.
 - .6 ASTM E1111-07, Standard Test Method for Measuring the Interzone Attenuation of Open Office Components.
 - .7 ASTM E1264-14, Standard Classification for Acoustical Ceiling Products.
 - .8 ASTM E1414/E1414M-11ae1 - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
 - .9 ASTM E1477-98a (2013) - Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.
 - .2 CAN/CGSB-92.1-M89, Sound Absorptive Prefabricated Acoustical Units.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B111-1974 (R2003), Wire Nails, Spikes and Staples.
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .2 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-07, Surface Burning Characteristics of Building Materials and Assemblies.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications, and data sheets.
 - .2 Submit WHMIS MSDS for products used on project.
- .3 Samples:
 - .1 Samples: Submit duplicate manufacturer samples illustrating material and finish of acoustic units.
 - .2 Samples: Submit duplicate samples of suspension system, 150 mm (6 inches) long.
- .4 Installation Data: Provide manufacturer's special installation requirements.
- .5 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Fire-resistance rated floor/ceiling and roof/ceiling assembly: certified by Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Extra Stock Materials:
 - .1 Provide extra materials of acoustic units in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type required for project.
 - .3 Ensure extra materials are from same production run as installed materials.
 - .4 Clearly identify each type of acoustic unit, including colour and texture.
 - .5 Deliver to Departmental Representative, upon completion of the work of this section.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver acoustical ceiling units to project site in unopened manufacturer's packaging. Store in enclosed space and protect from damage.
- .2 Protect on-site stored or installed absorptive material from moisture damage.
- .3 Store extra materials required for maintenance, where directed by Departmental Representative.

1.5 ENVIRONMENTAL REQUIREMENTS

- .1 Permit wet work to dry before beginning installation.

- .2 Maintain uniform minimum temperature of 15°C and relative humidity of 20% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.

Part 2 Products

2.1 MATERIALS

- .1 Acoustic Ceiling Tile Suspension System:
 - .1 Non-fire Rated Grid: ASTM C635/C635M, intermediate duty cold rolled steel with hot dipped galvanized coating; components die cut and interlocking.
 - .2 Grid Materials: Commercial quality cold rolled steel with galvanized coating.
 - .3 Grid Profile:
 - .1 Field: 24 mm (15/16 inch) exposed 'T' for square lay-in tiles.
 - .2 Perimeter: 24 mm (15/16 inch) shadow reveal transition moulding.
 - .4 Grid Finish: Polyester paint, white.
- .2 Suspension System for Server Room: System to be capable of supporting fully populated ceiling grid, including blank panels, HVAC supply and return registers, light fixtures, cable trays, utility racks and other accessories.
 - .1 Suspension components:
 - .1 Grid connectors: Heavy duty zinc alloy casting connectors for grid intersections and to suspend grid system with 3/8-16 threaded rods.
 - .1 Fasteners: ¼-20 Phillips drive button head cap screws to fasten connectors to extruded aluminum grid members.
 - .2 Threaded Starter Rod and Turnbuckle: 3/8-16 RH/LH, 200 mm (8 inches) long, zinc plated, 3/8-16 threaded rod and 150 mm (6 inch) body zinc plated steel turnbuckle spaced at 1220 mm (48 inch) centers along main runners, for a 610 x 1220 mm (24 x 48 inch) nominal suspension from building structure.
 - .2 Grid: Extruded aluminum alloy 6063-T5 with 204-R1 etched, clear anodized finish.
 - .1 Grid profile: 38 mm (1-1/2 inch) wide face with continuous integral thread boss within the web for attachment of intersection connectors at any point along top of grid members.
- .3 ACT-1 for areas outside of LAN Room: Acoustic units to CAN/CGSB 92.1 and ASTM E1264, Type IV, Form 2, Pattern E.
 - .1 Composition: Wet-formed mineral fibre with acoustically transparent membrane. Fire Class A.
 - .3 Texture: Fine.
 - .4 Fire ratings to CAN/ULC S102:

- .1 Flame spread: Maximum 25.
- .2 Smoke developed: Maximum 50.
- .5 Noise Reduction Coefficient (NRC) to ASTM C423: Minimum 0.80.
- .6 Ceiling Attenuation Class (CAC): Minimum 35.
- .7 Articulation Class (AC) to ASTM E1110 and ASTM E1111: Minimum 170.
- .8 Light Reflectance (LR) range to ASTM E1477: 0.87.
- .9 Edge type: Square lay-in.
- .10 Colour: White.
- .11 Size: 610 x 1220 mm (24 x 48 inches).
- .12 Thickness: 22 mm (7/8 inch).
- .13 Surface coverings: Scrim with factory applied latex paint.
- .1 ACT-2 for LAN Room: Acoustic units to CAN/CGSB 92.1 and ASTM E1264, Type IV, Form 2, Pattern E.
 - .1 Composition: Wet-formed mineral fibre with vinyl-faced membrane. Fire Class A.
 - .3 Texture: Smooth.
 - .4 Fire ratings to CAN/ULC S102:
 - .1 Flame spread: Maximum 25.
 - .2 Smoke developed: Maximum 50.
 - .5 Ceiling Attenuation Class (CAC): Minimum 40.
 - .6 Light Reflectance (LR) range to ASTM E1477: 0.80.
 - .7 Edge type: Square lay-in.
 - .8 Colour: White.
 - .9 Size: 610 x 1220 mm (24 x 48 inches).
 - .10 Thickness: 16 mm (5/8 inch) nominal.
 - .11 Surface coverings: Acoustically transparent membrane with factory applied latex paint.
- .2 Attachment devices: Size for five times design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
- .3 Wire for hangers and ties: To ASTM A641/A641M, Class 1 zinc coating, soft annealed, with yield stress load at least 3 times design load, but not less than 12 gauge.
- .4 Staples, nails, and screws: To CSA B111, non-corrosive finish as recommended by acoustic unit manufacturer.
- .5 Adhesive: Low VOC type recommended by acoustic unit manufacturer.
- .6 Touch-Up Paint: Type and colour to match acoustic and grid units.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for acoustical ceiling tile and track installation in accordance with manufacturer's written instructions.
- .2 Ensure following work is completed before installation of ceilings begins.
 - .1 Plastering, gypsum board finishing, and painting: completed and dry.
 - .2 Mechanical, electrical, other work above ceiling: completed.
 - .3 Heating, ventilating and air-conditioning systems: installed and operating.
 - .4 Layout light fixture and sprinkler head penetrations at centre of panel width.
 - .5 Plan HVAC inlets and outlets to occur within centre of panel system or provide for equal distance on each side parallel to length of panels.
- .3 Do not install acoustical panels and tiles until work above ceiling has been reviewed by Departmental Representative.
- .4 Verify layout of hangers will not interfere with other work.
- .5 Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans.

3.2 INSTALLATION

- .1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Co-ordinate ceiling work to accommodate components of other sections, including light fixtures, diffusers, speakers, cable trays, utility racks, sprinkler heads, and other items to be built into acoustical ceiling components.
- .3 Installation: To ASTM C636/C636M except where specified otherwise.
- .4 In fire-rated ceiling systems, secure lay-in panels with hold-down clips and protect over light fixtures, diffusers, air return grilles and other appurtenances according to Certification Organizations design requirements.
- .5 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers, grilles and speakers. Provide additional suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of each light fixtures and diffusers.
- .6 Finished ceiling system to be square with adjoining walls and level within 1:1000.
- .7 Expansion joints: As recommended by manufacturer.
- .8 Install acoustical units as indicated in reflected ceiling plan.
- .9 Scribe acoustic units to fit adjacent work. Butt joints tightly, terminate edges with moulding.
- .10 Site finish cut tile edges with touch-up paint.

3.3 APPLICATION

- .1 Install acoustic units to clean, dry and firm substrate.
- .2 Install acoustical units parallel to building lines with edge unit not less than 50% of unit width. Refer to reflected ceiling plan.
- .3 Scribe acoustic units to fit adjacent work. Butt joints tightly, terminate edges with moulding.

3.4 INTERFACE WITH OTHER WORK

- .1 Co-ordinate ceiling work to accommodate components of other sections, including light fixtures, diffusers, speakers, sprinkler heads, and other items to be built into acoustical ceiling components.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management and Disposal: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by acoustical ceiling installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Association of Textile Chemists and Colorists (AATCC)
 - .1 AATCC 134-2011, Electrostatic Propensity of Carpets.
- .2 ASTM International
 - .1 ASTM D2047-11, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
 - .2 ASTM D2240-05 (2010), Standard Test Method for Rubber Property—Durometer Hardness.
 - .3 ASTM D3389-10, Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader).
 - .4 ASTM E662-12, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - .5 ASTM E1155-14/E1155M-14, Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers.
 - .6 ASTM E2179-03 (2016), Standard Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors.
 - .7 ASTM F150-06 (2013), Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring.
 - .8 ASTM F970-07 (2011), Standard Test Method for Static Load Limit.
 - .9 ASTM F1344-12e1, Standard Specification for Rubber Floor Tile.
 - .10 ASTM F1861-08 (2012)e1 – Standard Specification for Resilient Wall Base.
 - .11 ASTM F2055-10, Standard Test Method for Size and Squareness of Resilient Floor Tile by Dial Gage Method.
 - .12 ASTM F2199-09 (2014), Standard Test Method for Determining Dimensional Stability of Resilient Floor Tile after Exposure to Heat.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B651-12, Accessibility for the Built Environment.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102.2-10, Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.2 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 tile adhesive, subfloor patching compound. Include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Submit 2 copies of WHMIS MSDS for products to be installed.
- .3 Samples:
 - .1 Submit duplicate sample rubber tiles, full size, in proposed colours and patterns.
 - .2 Submit duplicate 150 mm pieces of base, demonstrating profiles.
 - .3 Submit duplicate 100 mm pieces of transition strip in proposed colours and finish.
- .4 Shop Drawings: Indicate:
 - .1 Tile installation orientation.
 - .2 Seam layout.
 - .3 Cut-outs: Show locations where cut-outs are required.
 - .4 Edgings: Show location of edge mouldings.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for resilient flooring for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 DELIVERY, STORAGE, AND HANDLING

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

1.4 AMBIENT CONDITIONS

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hours before, during, and 48 hours after installation.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide extra materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Rubber tile: 15% of actual installed area, for maintenance use.
 - .2 Extra materials: same production run as installed materials.
 - .3 Identify each type of flooring.
 - .4 Deliver to Departmental Representative, upon completion of the work of this section.
 - .5 Store where directed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Rubber tile flooring: To ASTM F1344, Type I, Grade 1; homogeneous vulcanized rubber compound with random scattered design.
 - .1 Thickness: 3 mm.
 - .2 Dimensional stability (ASTM F2199): $\leq 0.15\%$ in both directions.
 - .3 Hardness (ASTM D2240): Minimum 85 Shore A.
 - .4 Squareness (ASTM F2055): ± 0.45 mm (± 0.018 inches).
 - .5 Slip resistance (ASTM D2047): Neolite dry 0.93; neolite wet 0.91.
 - .6 Abrasion resistance (ASTM D3389): ≤ 0.09 g (0.003 oz).
 - .7 Static generation (AATCC 134): < 2000 V at 20% RH.
 - .8 Sound absorption (ASTM E2179/ISO 140): Δ IIC 14; Δ Lw 10 dB.
 - .9 Sound generation: 67.2 dBA, 68.9 dBC and 20.9 sones.
 - .10 Static load (ASTM F970): ≤ 0.13 mm with 113 kg (≤ 0.005 inches with 250 lbs).
 - .11 Surface burning characteristics (CAN/ULC S102.2):
 - .1 Flame spread: ≤ 125 .
 - .2 Smoke developed: ≤ 370 .
 - .12 Colour: As selected by Departmental Representative.
- .2 Resilient base: To ASTM F1861, continuous, top set, composition homogeneous throughout material:
 - .1 Type: Rubber.
 - .2 Thickness: 3.2 mm.
 - .3 Height: 102 mm.
 - .4 Lengths: Cut lengths minimum 2400 mm.
 - .5 Profile:
 - .1 Cove with toe: For rubber floor.
 - .2 Straight (toeless): For carpeted floor.
 - .6 Colour: As selected by Departmental Representative.
- .3 Transition Mouldings: PVC with additives and colourants, homogeneous composition through material.
 - .1 Hardness to ASTM D2240: Minimum 85 Shore A.
 - .2 Abrasion resistance to ASTM D3389: 0.22 mg/cycle.
 - .3 Slip resistance: To meet ASTM D2047.
 - .4 Changes in level to comply with accessibility requirements of CSA B651:
 - .1 0 to 6 mm vertical rise: Vertical transition strip permitted.
 - .2 7 to 13 mm vertical rise: Bevelled transition, not to exceed 1:2 ratio for rise:run.

- .3 Over 13 mm vertical rise: Bevelled transition, not to exceed 1:12 ratio for rise:run.
 - .5 Provide adhesive as recommended by transition strip manufacturer.
- .4 Primers and adhesives: Types recommended by resilient flooring manufacturer for specific material on applicable substrate.
 - .1 Resilient flooring adhesives: As recommended by resilient flooring manufacturer. Select adhesive for access floor system serviced with suction-type lifter tool.
- .5 Sub-floor filler and leveller: Self-levelling cementitious compound capable of bonding to properly prepared substrate surfaces.
 - .1 Compressive strength: Minimum 36.5 MPa (5300 psi) at 28 days.
 - .2 Capable of being walked on without damage after 3 hours.
 - .3 Capable of being coated after 24 hours at 21°C.
- .6 External corner protectors: type recommended by flooring manufacturer.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 EXAMINATION

- .1 Verify conditions of substrates are acceptable for product installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.
- .2 Ensure concrete floors are clean and dry by using test methods recommended by flooring manufacturer.
- .3 Confirm flatness of substrate by measurements taken in accordance with ASTM E1155/E1155M.
 - .1 Composite flatness (F_F): Minimum 36.
 - .2 Composite levelness (F_L): Minimum 20.

3.3 PREPARATION

- .1 Remove existing resilient flooring.

- .2 Remove or treat old adhesives to prevent residual old flooring adhesives from bleeding through to new flooring and/or interfering with the bonding of new adhesives.
- .3 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler cured and dry.
- .4 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .5 Prime concrete slab to resilient flooring manufacturer's printed instructions.

3.4 APPLICATION: FLOORING

- .1 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system. Maintain extra ventilation for at least one month following building occupation.
- .2 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .3 Lay flooring with seams parallel to building lines to produce a minimum number of seams.
 - .1 Border widths: minimum 1/3 width of full material.
- .4 As installation progresses, and after installation, roll flooring with 45 kg minimum roller to ensure full adhesion.
- .5 Cut flooring around fixed objects.
- .6 Install flooring in pan type floor access covers.
- .7 Continue flooring over areas that will be under built-in furniture.
- .8 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.
- .9 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .10 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.5 INSTALLATION TO ACCESS FLOORING SYSTEM

- .1 Adhere resilient tiles directly to access floor panels.
- .2 Install with tile sides square and flush to access floor panel edges.

3.6 APPLICATION: BASE

- .1 Clean substrate.
- .2 Install resilient base in lengths as long as practicable, without gaps at seams, and with tops of adjacent pieces aligned.

- .3 Do not stretch resilient base during installation.
- .4 Set base against wall and floor surfaces tightly with using 3 kg hand roller.
- .5 Install base straight and level, with base in continuous contact with horizontal and vertical substrates.
- .6 Mitre base at corners.
- .7 Scribe and fit to door frames and other obstructions.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management and Disposal: Remove waste material in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Remove excess adhesive from floor, base and wall surfaces without damage.
- .4 Clean, seal and wax floor and base surface to flooring manufacturer's printed instructions.

3.8 PROTECTION

- .1 Protect new floors from time of final set of adhesive until final inspection.
- .2 Prohibit traffic on floor for 48 hours after installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Association of Textile Chemists and Colorists (AATCC)
 - .1 AATCC Test Method 134-2011, Electrostatic Propensity of Carpets.
 - .2 AATCC Test Method 175-2013, Stain Resistance: Pile Floor Coverings.
- .2 ASTM International
 - .1 ATSM D5252-15, Standard Practice for the Operation of the Hexapod Tumble Drum Tester.
 - .2 ASTM E1155/E1155M-14, Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers.
 - .3 ASTM F2170-11, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 4.129-93, Carpets for Commercial Use.
 - .2 CAN/CGSB 4.2 No. 76-94/ISO 2551:1981, IDT (R2013), Textile Test Methods - Machine-Made Textile Floor Coverings - Determination of Dimensional Changes Due to the Effects of Varied Water and Heat Conditions.
 - .3 CAN/CGSB 4.2 No.77.1-94/ISO 4919:1978 (R2012), Textile Test Methods - Carpets - Determination of Tuft Withdrawal Force.
- .4 Carpet and Rug Institute (CRI)
 - .1 CRI Carpet Installation Standard 2011.
 - .2 CRI Green Label Plus Indoor Air Quality Testing Program.
- .5 National Floor Covering Association of Canada (NFCA)
 - .1 Floor Covering Reference Manual, latest edition.
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.2 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 each carpet tile, adhesive, and subfloor patching compound; include product characteristics, performance criteria, physical size, finish, and limitations.

- .2 Submit WHMIS MSDS.
- .3 Shop Drawings: Indicate:
 - .1 Tile installation orientation.
 - .2 Cut-outs: Show locations where cut-outs are required.
 - .3 Edgings: Show location of edge mouldings and edge bindings.
- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Submit duplicate samples of each type of carpet tile specified and duplicate tiles for each colour selected.
- .5 Certificates: Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .6 Manufacturer's Instructions: Submit manufacturer's installation and storage instructions.
- .7 Qualification Statements:
 - .1 Compliance: To CAN/ULC S102.2.
 - .2 Testing: Passes testing requirements of:
 - .1 Green Label Plus Indoor Air Quality Testing Program.
 - .3 Tuft bind: meets requirements of CAN/CGSB 4.129 when tested to CAN/CGSB 4.2 No.77.1.

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 installed products for incorporation into manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra stock materials: Deliver to Owner extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Section 01 78 00 - Closeout Submittals.
 - .1 Quantity: Provide extra carpet tile, minimum 10% of area installed.

1.5 QUALITY ASSURANCE

- .1 Provide material from same dye lot.

1.6 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 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
 - .3 Store and protect carpet tile in original containers or wrapping with manufacturer's seals and labels intact.
 - .4 Store and protect carpet tile and accessories in location as directed by Departmental Representative.
 - .5 Store carpet and adhesive at minimum temperature of 18°C and relative humidity of maximum 65% for minimum 48 hours before installation.
 - .6 Prevent damage to materials during handling and storage. Keep materials under cover and free from dampness.
 - .7 Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.
 - .8 Replace defective or damaged materials with new.

1.7 SITE CONDITIONS

- .1 Moisture: Ensure substrate is within moisture limits and alkalinity limits recommended by manufacturer. Prepare moisture testing and provide report to Departmental Representative.
- .2 Temperature: Maintain ambient temperature of not less than 18°C from 48 hours before installation to at least 48 hours after completion of work.
- .3 Relative humidity: Maintain between 10% and 65% for 48 hours before, during and 48 hours after installation.
- .4 Install carpet after space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete.

Part 2 Products

2.1 PERFORMANCE

- .1 Pile Surface Appearance: Level loop.
- .2 Pile fibre: To CAN/CGSB 4.129, BCF Nylon.
- .3 Colour and pattern: Subtle artful crosshatching pattern complete with rich textures, textural contrast with value shift.
 - .1 Confirm selection with Departmental Representative.
- .4 Flammability: To CGSB 4.129.
- .5 Dyeing method: 100% solution dyed.
- .6 Primary backing: Woven polypropylene.

- .7 Secondary backing: Woven synthetic.
- .8 Pile weight: Minimum 600 g/m².
- .9 Machine gauge: 39.4 rows/10 cm.
- .10 Density: Minimum 12.0 kilotex/cm².
- .11 Stitch count: Minimum 46.1 stitches/10 cm.
- .12 Pile height: Maximum 4.0 mm.
- .13 Stain resistance: Minimum 8.0 to AATCC 175.
- .14 Fibre shape: Maximum modification ratio 2.2 for soil release capability for high traffic area carpet.
- .15 Dimensional Stability: maximum + 0.12% to CAN/CGSB 4.2 No. 76/ISO 2551.
- .16 Static control: Maximum 3.0 kV to AATCC 134.
- .17 Air quality: To CCI/CRI Green Label Plus requirements.
- .18 Anti-microbial resistance: Permanent treatment to prevent growth of bacteria and fungi.

2.2 ACCESSORIES

- .1 Base: Refer to Section 09 65 16 – Resilient Flooring.
- .2 Adhesive film tabs: Polyethylene film tabs with pressure sensitive adhesive, as recommended by carpet manufacturer.
- .3 Sub-floor filler and leveller: Self-levelling cementitious compound capable of bonding to properly prepared substrate surfaces.
 - .1 Compressive strength: Minimum 20.6 MPa (3000 psi) at 28 days.
 - .2 Capable of being walked on without damage after 3 hours.
 - .3 Capable of being coated after 24 hours at 21°C.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for carpet tile installation in accordance with manufacturer's written instructions.
 - .1 Inform Departmental Representative of unacceptable conditions.
 - .2 Proceed with installation only after unacceptable conditions have been remedied.
- .2 Confirm flatness of substrate by measurements taken in accordance with ASTM E1155/E1155M.
 - .1 Composite flatness (F_F): Minimum 25.
 - .2 Composite levelness (F_L): Minimum 20.

- .3 Moisture requirements:
 - .1 Relative humidity to ASTM F2170: < 95%.

3.2 PREPARATION

- .1 Subfloor Preparation:
 - .1 Inspect concrete and determine special care required to make it a suitable for carpet.
 - .2 Fill and level cracks 3 mm wide or protrusions over 0.8 mm with appropriate and compatible patching compound.
 - .3 Comply with manufacturer's written recommendations for maximum patch thickness.
 - .4 Prime large patch areas with compatible primer.
 - .5 Ensure concrete substrates are cured, clean, and dry.
 - .6 Ensure concrete substrates are free of paint, dirt, grease, oil, curing or parting agents, and other contaminants, including sealers, that interfere with the bonding of adhesive.
 - .7 Where powdery or porous concrete surface is encountered, apply primer compatible with adhesive to provide a suitable surface for glue-down installation.
- .2 Surface Preparation: Prepare surface in accordance with manufacturer's written recommendations and in accordance with CRI Carpet Installation Standard.
- .3 Tile Carpeting Preparation: Pre-condition carpeting in accordance with manufacturer's written instructions.

3.3 INSTALLATION

- .1 Install carpet tiles in accordance with manufacturer's written instructions, and CRI Carpet Installation Standard and co-ordinate with Section 01 73 00 - Execution.
- .2 Confirm layout of carpet tile with Departmental Representative prior to installation.
- .3 Co-ordinate tile carpeting work with work of other trades, for proper time and sequence to avoid construction delays.
- .4 Install carpet tile after finishing work is completed, but before electrical pedestal outlets are installed.
- .5 Snugly join carpet tiles in completed installation.
 - .1 Measure distance covered by 11 carpet tiles (10 joints) and ensure distance complies with manufacturer specifications.
 - .2 Do not trap yarn between carpet tiles.
- .6 Ensure finished installation presents smooth wearing surface free from conspicuous seams, burring and other faults.
- .7 Ensure colour, pattern, and texture match within visual areas.

- .8 Maintain constant pile direction.
- .9 Scribe tiles around architectural, mechanical, electrical, and telephone outlets, and furniture fitments, around perimeter of rooms into recesses, and around projections.
- .10 Install carpet tiles to access covers.
- .11 Extend carpet tiles into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- .12 Install carpet tiles smooth and free from bubbles, puckers, and other defects.
- .13 Protect exposed carpet tile edges at transition to other flooring materials with suitable transition strips.

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.
 - .1 Vacuum carpets clean immediately after completion of installation, using commercial machine with face-beater element.
- .2 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Install carpet protection to satisfaction of Departmental Representative.
- .3 Repair damage to adjacent materials caused by tile carpeting installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Ceilings and Interior Systems Construction Association (CISCA)
 - .1 Recommended Test Procedures for Access Floors - 2007.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102.2-10, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: convene pre-installation meeting after Award of Contract and 1 week prior to commencing work of this Section to verify project requirements, substrate conditions, co-ordination with other building sub-trades, and to review manufacturer's written installation instructions.
 - .1 Convene pre-installation meeting 1 week prior to beginning on-site installation, in accordance with Section 01 31 19 - Project Meetings.
 - .2 Notify attendees 2 weeks prior to meeting and ensure meeting attendees include as minimum:
 - .1 Departmental Representative.
 - .2 Access flooring subcontractor.
 - .3 Ensure meeting agenda includes review of methods and procedures related to access flooring installation including co-ordination with related work.
 - .4 Record meeting proceedings including corrective measures and other actions required to ensure successful completion of work and distribute to each attendee within 1 week of meeting.

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for access flooring. Include product characteristics, performance criteria, physical size, finishes, and limitations.
 - .2 Submit WHMIS MSDS for products used in the project.
- .3 Shop Drawings: Submit shop drawings for access flooring at start-up meeting.

- .1 Take measurements from finished area at site. Indicate where applicable information as follows:
 - .1 Layout of work.
 - .2 Sizes and details of components.
 - .3 Anchorage methods.
 - .4 Edge and fascia details.
 - .5 Elevation differences.
 - .6 Handrail and ramp framing and details.
 - .7 Lateral bracing.
 - .8 Typical cut-out details.
 - .9 Plenum acoustic baffle details.
 - .10 Gasketing, return air details, supply air registers. Include air transfer capacity of grilles, registers and panels.
 - .11 Floor finishes.
 - .12 Location of connection to building grounding electrode.
- .4 Samples:
 - .1 Submit one full size sample consisting of 4 panels of complete access flooring system, including finishes.
 - .1 Accepted samples will be returned for inclusion in Work of this section.
 - .2 Submit one of each of following components.
 - .1 Full size floor panel.
 - .2 Pedestal.
 - .3 Stringer member.
 - .4 Handrail – minimum 50 mm wide section of rail, demonstrating profile and material finish.
- .5 Certificates: Submit certification, to demonstrate compliance of access flooring system to specification as follows:
 - .1 Letter of certification from responsible official of manufacturer.
 - .2 Method for testing access flooring in accordance with Ceilings and Interior Systems Construction Association (CISCA) standard test procedures.
 - .3 Test reports certifying that the product meets standard.
 - .1 Tests: performed by an independent testing laboratory regularly engaged in testing of access floor components.
- .6 Closeout submittals:
 - .1 Maintenance materials:
 - .1 Floor panels, equal to 15% of actual installed area.

1.4 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 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 indoors in dry location and in accordance with manufacturer's recommendations, in clean, dry, well-ventilated area.
 - .2 Store and protect access flooring from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Access floor system: Raised, adjustable access flooring system consisting of support system, interchangeable flooring panels, bases, and associated components and accessories.
 - .1 Support system:
 - .1 Removable stringer grid, unexposed.

2.2 DESIGN REQUIREMENTS

- .1 Pedestals:
 - .1 Pedestal assembly to support a concentrated load of 5.6 kN (1250 lbs) at any location on the panel.
 - .2 Ultimate load carrying capacity: Minimum twice design load.
- .2 Floor Panels:
 - .1 Panels are to be interchangeable.
 - .2 Panels are to be easily removable by one person using lifting device.
 - .3 Uniformly distributed load of 21.5 kPa (450 lbs/ft²) minimum: maximum deflection of 1.5 mm (1/16 inch).
 - .4 Rolling load of 568 kg (1250 lbs) on 76 mm diameter x 46 mm wide caster with bearing area of at any location on panel without damage, maximum deformation of 1.0 mm (0.040 inches).
 - .5 Permanent deflection: 0.5 mm maximum at design load.
 - .6 Ultimate strength of the panel: provide safety factor of 2.0 times design load without failure.
- .3 Floor panel tolerances:
 - .1 Flatness: ± 0.75 mm (0.030 inches) measured on a diagonal.
 - .2 Flatness: ± 0.63 mm (0.025 inches).
 - .3 Width or length: ± 0.4 mm (0.015 inches).
 - .4 Squareness: ± 0.5 mm (0.020 inches).
- .4 Fire resistance of floor panels, less finish flooring, to CAN/ULC S102.2:

- .1 Flame spread: 0.
- .2 Fuel contribution: 0.
- .3 Smoke development: 5.

2.3 MATERIALS

- .1 Pedestals: Steel welded assembly; threaded supporting rod with vibration-proof locknut and 25 mm adjustment range, for floor heights ≥ 150 mm; corrosion-resistant finish.
 - .1 Pedestal head: Hot dip galvanized formed steel,
 - .2 Pedestal base: Hot dip galvanized formed steel, minimum 10,000 mm² (16 in²) bearing area.
- .2 Panels: Formed bottom steel pan filled with lightweight cementitious composite fibre compound, with steel top plate; panel size 610 x 610 mm.
 - .1 Provide factory made cut-out panels for items passing through access floor panels, including grommets and diffusers.
 - .2 Finish flooring: Refer to Section 09 65 16 – Resilient Flooring.
- .3 Stringers: Steel, mechanically locked to pedestal head, removable.
 - .1 Finish: Conductive sound absorbent gasket coating.
- .4 Fascia panels: Sheet steel, galvanized.
 - .1 Include required corner pieces, trim, reinforcing and fixing angles.
 - .2 Finish:
 - .1 Steel: Baked enamel. Colour as selected by Departmental Representative.
 - .2 Aluminum: Clear anodizing.
- .5 Ramps and support system: of same materials, structural strength, and construction as floor panels. Cover open joints with sheet steel cover plates.
 - .1 Terminate ramp with ramp shoe and threshold transition plate; include fascia/closure plate.
- .6 Railings: posts and rails of extruded aluminum assembled with sleeved connections. Include end caps, floor sockets and collars, brackets and fittings.
 - .1 Finish: Clear anodizing.

2.4 PLENUM ACOUSTIC BAFFLE ACCESSORIES

- .1 Plenum divider: Galvanized steel sheet, 1.6 mm (16 gauge) minimum thickness.
- .2 Plenum sound baffles: Insulation blanket.
 - .1 Core: Fibreglass insulation.
 - .2 Face: 0.076 mm thick fibreglass cloth.
 - .3 Backing: 0.20 mm aluminum foil laminated to Kraft paper.

- .4 Blanket loop stitching at 100 mm on centre.
- .3 Plenum gasketing: Closed cell neoprene, self-extinguishing and non-burning, designed to seal between panel and plenum divider.

2.5 ACCESSORIES

- .1 Panel lifting device: 1 per enclosed area, manufacturer's standard equipment, type recommended for each panel type. Include wall mounting bracket for panel lifter.
- .2 Adhesives: moisture-resistant, electrically conductive type as recommended by manufacturer of material to be bonded.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate are acceptable for access flooring installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 INSTALLATION

- .1 Install components in accordance with system manufacturer's written recommendations.
- .2 Pedestals and stringers:
 - .1 Arrange pedestal assemblies to meet grid spacing required.
 - .2 Bond pedestal base plate to structural floor with adhesive.
 - .3 Install additional pedestal assemblies to maintain load capacity where grid pattern is disturbed by columns, walls, ramps, openings, and steps, and at cut-outs that impair floor load capacity.
 - .4 Install stringers to rigidly brace floor pedestals four ways.
- .3 Plenum acoustic baffles:
 - .1 Install acoustic baffles in plenum area of access flooring installation.

- .2 Attach plenum dividers to sub-floor with adhesive applied to full length of the divider, ensuring no gaps between divider and floor.
- .3 Seal joints at divider-panel and divider-sub-floor interfaces with plenum gasketing.
- .4 Floor panels:
 - .1 Install floor panels and floor finish solidly on pedestals, level to maximum variation over entire floor of 1:2000.
 - .2 Install floor boxes where indicated.
 - .3 Install ramp panels similarly to floor panels, securely fixed. Include shoe at top and bottom of ramp.
 - .4 Seal field cuts with plastic angles or channels. No exposed cut edges permitted.
 - .5 Allow for cutting holes in floor panels for installation of floor boxes. Include cable protection edging or sheet.
 - .6 Provide floor, ramp complete with necessary edge trims, end closures and lateral bracing at step edges and other locations where pedestal is not braced four ways.
- .5 Fascia panels:
 - .1 Install fascia panels at exposed sides and ramp sides.
 - .2 Secure panels to continuous angles. Mechanically secure to structural floor and to edge of floor panels.
 - .3 Install metal trim at intersection of fascia panels and access floor and at abutting walls and columns.
- .6 Railings:
 - .1 Extend railing posts through floor panels to structural floor below, set into and secure to flanged fittings bolted to structural floor.
 - .2 Bolt posts in position at floor panels with retaining floor collar.
 - .3 Install railings at walls set into flanged fittings bolted to walls.
 - .4 Electrically insulate railings from, or directly ground to, access flooring system.
- .7 Provide electrical grounding connectors in accordance with Division 26 – Electrical.
- .8 Adjust floor panel system for smooth, quiet operation.

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.

- .1 Clean surfaces after installation using manufacturer's recommended cleaning procedures.
- .2 Clean aluminum with damp rag and approved non-abrasive cleaner.
- .3 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
 - .1 Protect finished access floor with 0.15 mm thick polyethylene film, sealed at edges to prevent tearing.
- .2 Repair damage to adjacent materials caused by access flooring installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM E84-12, Surface Burning Characteristics of Building Materials.
- .2 Gypsum Association (GA)
 - .1 GA-214-15, Recommended Levels of Finish for Gypsum Board, Glass Mat, and Fiber-Reinforced Gypsum Panels.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data:
 - .1 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29 – Health and Safety Requirements.
 - .2 Submit complete written description, including tensile strength, tear strength, and fire rating characteristics.
- .3 Samples:
 - .1 Due to product lead times, order material immediately upon approval of wall covering from Departmental Representative.
 - .2 Submit duplicate manufacturer samples of proposed dry erase wall coverings.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for dry erase wall covering in accordance with Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Field Sample:
 - .1 Before commencing application, prepare wall and apply samples of wall covering from current production run of materials selected to show evidence there are no roller marks or other imperfections which may occur during manufacturing process of wall covering to three full wall panels, for Departmental Representative's approval.

1.4 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: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 AMBIENT CONDITIONS

- .1 Temperature: Maintain air temperature and structural base temperature at wall covering installation area above 20°C and relative humidity below 40% for 72 hours before, during, and 72 hours after installation.
- .2 Ventilate area of work as directed by Departmental Representative.

1.6 MAINTENANCE

- .1 Extra Materials: Section 01 78 00 - Closeout Submittals.
 - .1 Provide 10 m² of full width material of each pattern, texture, and colour of dry-erase wall covering.
 - .2 Provide sufficient adhesive to install extra material wall covering provided.
 - .3 Provide extra materials from same production run as installed materials.
 - .4 Identify rolls of wall coverings and containers of adhesives.
 - .5 Deliver to Departmental Representative, upon completion of work of this section.
 - .6 Store where directed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Wall covering: Pigmented vinyl capped with non-glare film, heat embossed with bi-directional lenticular pattern, for projection and dry-erase markers.
 - .1 Backing: Non-woven.
 - .2 Thickness: 0.43 mm average.
 - .3 Tensile strength (warp x fill): 334 x 334 N.
 - .4 Flammability to ASTM E84: Pass.
 - .5 Surface: No gloss to low gloss.
- .2 Sealer: Type recommended by covering manufacturer.
- .3 Adhesive: As recommended by covering manufacturer.
- .4 Substrate primer and sealer: White pigmented acrylic base primer and sealer formulated for use with dry erase wall covering.
- .5 Locations: As shown on Drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 EXAMINATION

- .1 Verify conditions of substrates are acceptable for dry erase wall covering installation in accordance with manufacturer's instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.
- .2 Ensure substrate is to GA-214 Level 4 finish.
- .3 Verify substrate is clean, dry, smooth, structurally sound, and free from surface imperfections that may telegraph through finished surface.
- .4 Test substrate with moisture meter; ensure moisture content is not greater than 4%.

3.3 PREPARATION

- .1 Acclimatize wall covering minimum 24 hours in installation area before application.
- .2 Prepare surfaces according to wall covering manufacturer's instructions.
- .3 Ensure that work penetrating substrate is completed before installing dry erase covering.
- .4 Seal surfaces to receive dry erase covering.

3.4 INSTALLATION

- .1 Installation sequence:
 - .1 Use rolls in consecutive numerical sequence of manufacture.
 - .2 Place strips consecutively in exact order as cut from roll; including spaces above or below windows, doors, and other openings.
 - .3 Reverse alternate strips except on match patterns.
 - .4 Do not crease or bend wall covering when handling.
- .2 Apply adhesive to substrate as recommended by manufacturer.
- .3 Double-cut seams with seam cutting tool; do not score gypsum board substrate.
- .4 Install dry erase covering level, using a wall covering smoother wrapped with a soft cloth to remove air bubbles. Smooth material from middle to outside edges.
- .5 Avoid seams in main writing and viewing areas of wall.

- .6 Remove excess adhesive along finished seams immediately after strips of wall covering are applied.
- .7 Clean entire surface with warm, mild soap solution.
- .8 As work progresses ensure clean warm water is used for final rinsing of wall covering and leave clean.
- .9 Leave completed work smooth, clean, without wrinkles, gaps, overlaps, or air pockets.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Clean surfaces to covering manufacturer's written instructions.

3.6 PROTECTION

- .1 Protect finished surfaces and exterior corners from damage until final inspection.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S114-05, Test for Determination of Non-Combustibility in Building Materials.
 - .3 CAN/ULC S702-09, Standard for Mineral Fibre Thermal Insulation for Buildings.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets for products used in the Work.
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials in manufacturer's original containers clearly labeled with manufacturer's name, product identification, safety information, net weight of contents and expiration date.
- .2 Store material in a safe manner and where the temperatures are within range specified by manufacturer.
- .3 Remove empty containers from site on a daily basis.

1.4 WASTE MANAGEMENT AND DISPOSAL

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

1.5 PROJECT CONDITIONS

- .1 Maintain environmental conditions of temperature, humidity, and ventilation within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.
- .2 Ventilate area to receive insulation to maintain safe working conditions.
- .3 Protect workers as recommended by standards and manufacturer's recommendations.

Part 2 Products

2.1 BATT INSULATION

- .1 Acoustic batt insulation: To CAN/ULC S702, Type 1; non-combustible to CAN/ULC S114, semi-rigid stone wool batt insulation.
 - .1 Surface burning characteristics to CAN/ULC S102:
 - .1 Flame spread: 0.
 - .2 Smoke developed: 0.
 - .2 Airborne sound transmission loss: To ASTM E90.
 - .3 Sound absorption coefficients: To ASTM C423:

Thickness (mm)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
25	0.14	0.25	0.65	0.90	1.01	1.01	0.70
38	0.18	0.44	0.94	1.04	1.02	1.03	0.85
50	0.28	0.60	1.09	1.09	1.05	1.07	0.95
76	0.52	0.96	1.18	1.07	1.05	1.05	1.05
102	0.86	1.11	1.20	1.07	1.08	1.07	1.10

2.2 ACCESSORIES

- .1 Nails: Galvanized steel, length to suit insulation plus 25 mm, to CSA B111.
- .2 Staples: 12 mm minimum leg.
- .3 Tape: As recommended by manufacturer.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 GENERAL

- .1 Install insulation after building substrate materials are dry.
- .2 Install insulation to maintain continuity of sound absorption between partitioned spaces.
- .3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around doors and windows and other protrusions.
- .4 Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.
- .5 Offset both vertical and horizontal joints in multiple layer applications.
- .6 Do not enclose insulation until it has been inspected by Departmental Representative.

3.3 EXAMINATION

- .1 Examine substrates and immediately inform Departmental Representative in writing of defects.
- .2 Verify substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.
- .3 Verify acoustic and firestop sealants required at stud framing junctions with adjacent building components or at mechanical and electrical conduit and duct penetrations are installed.
- .4 Confirm mechanical, electrical, and telecommunications service lines in walls and ceilings to be insulated have been inspected.

3.4 BATT INSULATION INSTALLATION

- .1 Install acoustic insulation where indicated to maintain sound attenuation of separation in building elements and spaces.
- .2 Place acoustic blankets between studs ensuring friction fit, free of sags, folds, voids, or open joints that may let sound pass through.
- .3 Do not compress insulation excessively to fit voids.
- .4 Fit insulation closely around electrical boxes, pipes, ducts, frames, and other objects in or passing through insulation.

3.5 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .2 Repair damage to adjacent materials caused by insulation installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C423-07, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM E84-15a, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: Submit manufacturer's literature, indicating description of panel core materials, fabric, and fire rating characteristics. Indicate attachment hardware for each type of panel specified.
- .3 Samples.
 - .1 Submit duplicate manufacturer's samples of acoustical unit material.
 - .2 Submit duplicate manufacturer's samples of aluminum metal shell, showing perforation pattern and finish.

1.3 ENVIRONMENTAL REQUIREMENTS

- .1 Permit wet work to dry prior to commencement of installation.

1.4 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: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Acoustically absorptive batts: Pressed and formed recycled cotton batts, formaldehyde-free, treated with borate mould inhibitor.
 - .1 Thickness: 50 mm (2 inches).
 - .2 Density: 48 kg/m³ (3 lbs/cu ft).
 - .3 Surface burning characteristics (ASTM E84): Class A.
 - .1 Flame spread rating: 10 or lower.
 - .2 Smoke developed: 20 or lower.

2.2 SOUND ABSORPTIVE PANELS

- .1 Ceiling-mounted baffles:
 - .1 Material: Acoustically absorptive cotton batt, pressed and formed.
 - .2 Sound absorption (ASTM C423): Minimum 13.8 sabins.
 - .3 Panel dimensions: 610 x 1220 mm (24 x 48 inches).
 - .4 Mounting brackets: Extruded aluminum, profile as indicated.
 - .5 Colour: As selected by Departmental Representative from manufacturer's standard range.
- .2 Metal wall-mounted acoustic panels:
 - .1 Metal panels: Aluminum shell, 1 mm (0.040 inch) thickness, perforated.
 - .1 Perforations: 3.0 mm (0.117 inch) diameter, on 4.0 (5/32 inch) centers.
 - .2 Acoustic fill: Acoustically absorptive cotton batt.
 - .3 Metal support clips: Roll-formed, galvanized.
 - .4 Colour: As selected by Departmental Representative from manufacturer's standard range.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION – WALL-MOUNTED UNITS

- .1 Ensure substrate surface is straight to tolerance of plus or minus 3 mm over 3000 mm.
- .2 Install wall-mounted acoustic units to clean, dry and firm substrate using brackets and screws.
- .3 Install wall-mounted acoustic units plumb and aligned. Arrange units as indicated.
- .4 Install fibrous acoustical media over entire area in hollows of perforated acoustic shells.

3.3 INSTALLATION – CEILING-MOUNTED UNITS

- .1 Install ceiling-mounted units as indicated, using brackets and bolts.
- .2 Install ceiling-mounted acoustic units plumb and aligned. Arrange units as indicated.
- .3 Install with brackets to keep panels firmly fixed in place without sway.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Keep acoustic installation and all components clean. Remove blemishes immediately.

3.5 PROTECTION

- .1 Use polyethylene and cardboard to protect finished acoustical wall treatment from damage.
- .2 Remove prior to substantial completion.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Master Painters Institute (MPI)
 - .1 MPI Architectural Painting Specifications Manual, current edition.
 - .2 MPI Maintenance Repainting Manual, current edition.
- .4 National Fire Code of Canada - 2010.
- .5 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building sub-trades.
 - .4 Review installation instructions and warranty requirements.

1.3 SCHEDULING

- .1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.
- .2 Obtain written authorization from Departmental Representative for changes in work schedule.
- .3 Schedule painting operations to prevent disruption of occupants.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit product data and instructions for each paint and coating product to be used.
 - .2 Submit product data for the use and application of paint thinner.

- .3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS). Indicate VOCs during application and curing.
- .3 Samples:
 - .1 Submit full range colour sample chips to indicate where colour availability is restricted.
 - .2 Submit duplicate 200 x 300 mm sample panels of each paint and stain with specified paint or coating in colours, gloss/sheen, and textures required, to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
 - .1 3 mm plate steel for finishes over metal surfaces.
 - .2 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.
 - .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.
 - .4 Certificates: Submit certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical properties.
 - .5 Manufacturer's Instructions:
 - .1 Submit manufacturer's application instructions.
 - .6 Closeout Submittals: Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include following:
 - .1 Product name, type, and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.

1.5 MOCK-UPS

- .1 Mock-ups: Apply mock-ups of each paint system indicated, in each colour and finish selected, to verify preliminary selections made under sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Departmental Representative will select surfaces to represent surfaces and conditions for application of each paint system specified.
 - .1 Vertical and Horizontal Surfaces: Provide samples of at least 9 m² (100 ft²).
 - .2 Other Items: Departmental Representative will designate items or areas required.
 - .3 Apply mock-up samples after permanent lighting and other environmental services have been activated.
 - .4 Final approval of colour selections will be based on mock-ups.

- .1 If preliminary colour selections are not approved, apply additional mock-ups of additional colours selected by Departmental Representative at no added cost to contract.

- .5 Approved mock-up may remain as part of finished work.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Section 01 78 00 - Closeout Submittals.
 - .2 Quantity: Provide one 4 litre can of each type and colour of primer, stain, and finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Pack, ship, handle, and unload materials in accordance with Section 01 61 00 - Common Product Requirements and manufacturer's written instructions.
- .2 Identify products and materials with labels indicating:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened, and rejected materials from site.
- .4 Storage and Protection:
 - .1 Provide and maintain dry, temperature controlled, secure storage.
 - .2 Store materials and supplies away from heat generating devices.
 - .3 Store materials and equipment in well-ventilated area with temperature range 7°C to 30°C.
- .5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.
- .6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.
- .7 Remove paint materials from storage only in quantities required for same day use.
- .8 Fire Safety Requirements:
 - .1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

- .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.
- .9 Waste Management and Disposal:
 - .1 Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Place materials defined as hazardous or toxic in designated containers.
 - .4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, and Municipal regulations.
 - .5 Ensure emptied containers are sealed and stored safely.
 - .6 Dispose of unused paint and coating materials at official hazardous material collections site.
 - .7 Paint, stain and wood preservative finishes and related materials (thinners, and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.
 - .8 Material that cannot be reused is to be treated as hazardous waste and disposed of in an appropriate manner.
 - .9 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
 - .10 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:
 - .1 Retain cleaning water for water-based materials to allow sediments to be filtered out.
 - .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - .4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.
 - .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
 - .11 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

1.8 SITE CONDITIONS

- .1 Heating, Ventilation, and Lighting:
 - .1 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.

- .2 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
- .3 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .2 Temperature, Humidity, and Substrate Moisture Content Levels:
 - .1 Unless pre-approved written approval by Specifying body and product manufacturer, perform no painting when:
 - .1 Ambient air and substrate temperatures are below 10°C.
 - .2 Substrate temperature is above 32°C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.
 - .4 Relative humidity is under 85% or when the dew point is more than 3°C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3°C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning painting.
 - .5 Ensure conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.
 - .2 Perform painting work when maximum moisture content of the substrate is below:
 - .1 12% for plaster and gypsum board.
 - .3 Test for moisture using calibrated electronic Moisture Meter.
 - .4 Test plaster surfaces for alkalinity as required.
- .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.
- .4 Additional interior application requirements:
 - .1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

Part 2 Products

2.1 MATERIALS

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

- .2 Provide paint materials for paint systems from single manufacturer.
- .3 Conform to latest MPI requirements for interior painting work including preparation and priming.
- .4 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.
- .5 Linseed oil, shellac, and turpentine: Highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.
- .6 Use MPI listed materials having minimum E2 rating where indoor air quality (odour) requirements exist.
- .7 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:
 - .1 Manufactured without compounds that contribute to ozone depletion in the upper atmosphere.
 - .2 Manufactured without compounds that contribute to smog in the lower atmosphere.
 - .3 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- .8 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- .9 Flash point: 61.0°C or greater for water-borne surface coatings and recycled water-borne surface coatings.
- .10 Water-borne paints and stains, recycled water-borne surface coatings, and water borne varnishes to meet minimum "Environmentally Friendly" rating.

2.2 COLOURS

- .1 Selection of colours from manufacturers' full range of colours.
- .2 Where specific products are available in restricted range of colours, selection based on limited range.
- .3 Second coat in three-coat system to be tinted slightly lighter colour than topcoat to show visible difference between coats.

2.3 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Departmental Representative for tinting of painting materials.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer's instructions.

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

2.4 GLOSS/SHEEN RATINGS

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

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish (flat)	Max. 5	Max. 10
Gloss Level 2 - Velvet-Like Finish	Max.10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin-Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

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

2.5 INTERIOR PAINTING SYSTEMS

- .1 Galvanized metal: Doors and door frames; bollards, cantilever brackets for architectural woodwork:
 - .1 INT 5.3M – High performance architectural latex G5 finish (over waterborne galvanized primer).
- .2 Gypsum wallboard:
 - .1 INT 9.2B - High performance architectural latex.
 - .1 Walls: G4 finish.
- .3 Wood veneer faced doors:
 - .1 INT 6.3EE – Polyurethane varnish over waterborne stain – G4 (satin-like) finish.
- .4 Electrical backboards.
 - .1 INT 6.4PP – Fire retardant coating, pigmented, waterborne, MPI #64.
 - .1 Apply in accordance with manufacturer's instructions. Apply to all six sides of plywood electrical backboards.

2.6 INTERIOR REPAINTING

- .1 Steel – High Heat: Radiators.

- .1 RIN 5.2A – Heat-resistant enamel – maximum 205°C (400°F).
- .2 Galvanized metal: High contact/high traffic areas (doors, frames).
 - .1 RIN 5.3J – High performance architectural latex, G5 finish.
- .3 Gypsum wallboard:
 - .1 RIN 9.2B – High performance architectural latex.
 - .1 Walls: G4 finish.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage, and installation instructions, and data sheet.

3.2 GENERAL

- .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .3 Maximum moisture content as follows:
 - .1 Gypsum board: 12%.

3.4 PREPARATION

- .1 Protection:
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Departmental Representative.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
 - .3 Protect factory finished products and equipment.

- .4 Protect, building occupants and general public in and about the building.
- .2 Surface Preparation:
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, surface mounted equipment, fittings, and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.
- .3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and other surface debris by vacuuming, and wiping with dry, clean cloths.
 - .2 Wash surfaces with a biodegradable detergent and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.
 - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
 - .6 Use trigger operated spray nozzles for water hoses.
 - .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
- .4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.
- .5 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- .6 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes and vacuum cleaning.
- .7 Touch up of shop primers with primer as specified.
- .8 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

3.5 APPLICATION

- .1 Method of application to be as approved by Departmental Representative. Apply paint by brush and roller. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- .4 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .6 Sand and dust between coats to remove visible defects.
- .7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .8 Finish top, bottom, edges and cut-outs of doors after fitting as specified for door surfaces.

3.6 SITE TOLERANCES

- .1 Walls: No defects visible from 1000 mm at 90° to surface.
- .2 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.7 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing, and handling of paint to clean condition as approved by Departmental Representative.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM B221-14 – Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes.
- .2 PEI (Porcelain Enamel Institute) – PEI 1002 Manual and Performance Specifications for Porcelain Enamel Writing Surfaces.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's installation instructions, printed product literature and data sheets for visual display surfaces; include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Samples:
 - .1 Submit manufacturer's colour charts and composition samples of face, core, backing, and trims to illustrate finishes, colours, and textures.
- .4 Shop drawings: Indicate sizes, elevations, and locations for installation.
- .5 Closeout submittals: Provide manufacturer's maintenance literature for incorporation into O&M manual, including instructions for regular cleaning, stain removal, and precautions.

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 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 from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 VISUAL DISPLAY SURFACES

- .1 Dry erase marker board:
 - .1 Writing Surface Face Sheet: To PEI-1002, enamelling grade cold rolled steel, with porcelain enamel coating.

- .1 Coating thickness: Minimum 0.16 mm (6.5 mils).
 - .2 Coating colour: White, low gloss.
- .2 Writing Surface Core: MDF, 11 mm (7/16 inch) thick.
- .3 Writing Surface Backing: Moisture barrier.
- .4 Sizes: As indicated.
- .5 Aluminum trim: To ASTM B221; 6063-T5 alloy aluminum.
 - .1 Extruded aluminum channel trim, 16 mm (1-1/4 inch) wide face, mitered corners; one piece full length; clear anodized finish.
- .6 Accessories:
 - .1 Marker Tray: Continuous, solid, blade-type extruded aluminum tray, ribbed section, end closures, bottom mounted.
 - .2 Map Rail: Continuous, extruded aluminum, 25 mm (1 inch) wide map rail with cork insert and end stops, top mounted; confirm colour with Departmental Representative.
- .2 Tack board: Panel of cork laminated to backing, with aluminum trim.
 - .1 Face sheet: Cork, self-healing, burlap backing, 6 mm (1/4 inch) thick.
 - .1 Colour: As selected by Departmental Representative.
 - .2 Cork sheet backing: Hardboard, 6 mm (1/4 inch) thick.
 - .3 Sizes: As indicated.
 - .4 Aluminum trim: To ASTM B221; 6063-T5 alloy aluminum.
 - .1 Extruded aluminum channel trim, 16 mm (1-1/4 inch) wide face, mitered corners; one piece full length; clear anodized finish.

2.2 FABRICATION

- .1 Fabricate dry erase boards and tack boards off-site.
- .2 Fabricate with aluminum trim applied to full length of all edges of dry erase boards and tack boards.
- .3 Reinforce corners with angles to strengthen frame.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate are acceptable for installation in accordance with manufacturer's written instructions. Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Install dry erase boards and tack boards to manufacturer's written instructions.
- .2 Confirm location and height with Departmental Representative prior to installation.

- .3 Mechanically attach dry erase boards and tack boards using heavy duty metal screws. Secure to framing members in stud walls.
- .4 Install units level and plumb.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.4 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Section 01 33 00: Submission Procedures.
- .2 Shop Drawings: Indicate sign styles, lettering font, colours, locations, and overall dimensions of each sign.
- .3 Installation Data: Manufacturer's special installation requirements. Include installation template and attachment devices.

1.2 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 61 00: Transport, handle, store, and protect products.

Part 2 Products

2.1 SIGNS

- .1 Signs: Acrylic plastic face plate with metal frame, with sliding tab at bottom to switch display between "OCCUPIED" and "UNOCCUPIED".
 - .1 Frame and face plate colour: Black.
 - .2 Character colour: White.
 - .3 Dimensions: 200 x 200 mm (8 x 8 inches).
 - .4 Corners: Radiused.
 - .5 Edges: Square.
 - .6 Character Font: Helvetica.

2.2 ACCESSORIES

- .1 Tape Adhesive: Double sided foam tape, permanent adhesive.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify existing conditions before starting work.
- .2 Verify that substrate surfaces are ready to receive work.

3.2 INSTALLATION

- .1 Install signage to manufacturer instructions.

- .2 Install signs after surfaces are finished, in locations as directed.
- .3 Locate sign on wall surface, level.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .2 ASTM E336-05, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings.
 - .3 ASTM E557-12, Standard Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions.
- .2 Canadian Standards Association (CSA)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part I.
- .3 (NEMA)
 - .1 NEMA MG1-2014, Motors and Generators.
- .4 Underwriters' Laboratories
 - .1 UL 508A-2013, Industrial Control Panels.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 DESIGN REQUIREMENTS

- .1 Design and fabricate folding partitions with minimum STC of 45 tested to ASTM E90.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29 – Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba.
 - .1 Indicate installation requirements including dimensions, head and jamb conditions, track layout, stacking arrangement, switching,

hardware, finish and colour, operating mechanism, electrical requirements and location.

- .4 Samples:
 - .1 Submit duplicate 300 x 300 mm samples of partition finish for each colour selected.
- .5 Quality assurance/control submittals: Submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: Submit certified test reports for folding panel partitions from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Submit test data indicating compliance with design requirements regarding sound transmission and fire hazard classification.
 - .3 Submit acoustical test data to ASTM E90 and ensure construction details and weight are provided.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Manufacturer's Instructions: submit manufacturer's installation instructions. Indicate special handling criteria, installation sequence, cleaning procedures.
 - .6 Manufacturer's Field Reports: manufacturer's field reports specified.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for folding panel partitions for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Site Meetings: As part of Manufacturer's Services described in PART 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.
 - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.

1.5 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 OPERATION

- .1 Series of continuously hinged flat panels, electrically operated, top supported with operable floor seals.
- .2 Final Closure: Side Jamb.
- .3 Partition operation to be by two push button control stations wired in series and located on opposite sides of the partition. Control stations to be activated by key switch at stack end of partition. Motor unit to be reversible, continuous duty, and class A insulated. Motor unit to have NEMA MG1 service factor, high starting torque, thermal overload protection, and open/drip proof enclosure. Motor assembly to have wiring compliant with CSA 22.1, 24 volt controls, compliant with UL508A, and speed of 28 feet/minute. Drive unit motor to be equipped with outboard limit switches to prevent over-extension. Positive-chain drive attached to lead panel to pull partition across opening.
- .4 Cable, belt, and other friction type drives are not acceptable.
- .5 Electric motor: 208-volt, 3-phase.

2.2 PANEL CONSTRUCTION

- .1 Nominal 76 mm thick panels in manufacturer's standard widths. All panel horizontal and vertical framing members fabricated from minimum 18 gauge formed steel with overlapped and welded corners for rigidity. Top channel reinforced to support suspension system components. Frame designed with full vertical edges of formed steel panels and concealed protection of panel skin edges.
- .2 Panel skin: Roll-formed steel wrapping around panel edge. Panel skins lock formed and welded directly to frame for unitized construction.
- .3 Acoustical ratings of panels: Minimum 52 STC.
- .4 Hinges for Panels: Full leaf butt hinges, attached directly to panel frame with welded hinge anchor plates within panel.
 - .1 Hinges mounted into panel edge or vertical astragal are not acceptable.
- .5 Panel Trim: No vertical or horizontal trim required or allowed on edges of panels; minimal groove appearance at all panel joints.
- .6 Provide panels with finished end caps.
- .7 Panel finish: Upholstery fabric with stain resistance treatment.

2.3 SOUND SEALS

- .1 Vertical interlocking sound seals between panels: Roll-formed steel astragals, with reversible tongue and groove configuration in each panel edge for universal panel operation. Rigid plastic astragals or astragals in only one panel edge are not acceptable.

- .2 Top seals: Continuous contact extruded vinyl bulb shape with pairs of non-contacting vinyl fingers to prevent distortion without the need for mechanically operated parts.
- .3 Bottom seal: Floating operable seals; 89 mm operating clearance within +15 mm to -76 mm operating range; provide continuous floor contact as panels are positioned.

2.4 SUSPENSION SYSTEM

- .1 Suspension Tracks: Minimum 7-gauge, 4.57 mm roll formed steel. Static loading of track with brackets at 1220 mm centers to show no failure of track or brackets at 2550 kg point loading at mid-span. Track to be supported by adjustable steel hanger brackets connected to structural support pairs of 13 mm diameter threaded rods. Brackets to support load bearing surface of track.
 - .1 Exposed track soffit: Steel, removable for service and maintenance, attached to track bracket without exposed fasteners, and pre-painted off-white.
- .2 Carriers: All-steel trolley with four or eight steel-tired ball-bearing wheels. Non-steel tires are not acceptable.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Comply with ASTM E557, operable partition manufacturer's installation instructions, drawings, and shop drawings.
- .2 Secure and level track.
- .3 Touch up damaged finishes, repair damage to partitions to match original finish.
- .4 Clean folding partition system and protect from damage.
- .5 Adjust and leave partitions in smooth operating condition.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

- .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - 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 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 end caps and corner guards; include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS in accordance with Section 01 35 29 - Health and Safety Requirements. Indicate VOC's for adhesives.
- .3 Installation Drawings: Indicate on drawings large scale details, materials, finishes, dimensions, anchorage and assembly.
- .4 Samples: Submit duplicate manufacturer's samples of profiles for end caps and corner guards.

1.2 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 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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wall and corner guards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 End Caps and Corner Guards: Surface mount stainless steel, 38 mm (1-1/2 inch) leg, 3 mm (1/8 inch) radius, edge burrs removed.
 - .1 Material: Minimum thickness 1.6 mm (0.063 inch, 16 gauge), stainless steel, type 304 or 316.
 - .2 Finish: No. 4 satin finish, grain oriented parallel with length.
 - .3 Height: As indicated.
 - .4 Exposed fasteners are not permitted for attachment of corner guards and end caps.

2.2 ACCESSORIES

- .1 Adhesive: Water resistant type as recommended by manufacturer for substrate.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate are acceptable for end cap and corner guard installation in accordance with manufacturer's instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 INSTALLATION

- .1 Install units on solid backing and erect with materials and components straight, tight, and in alignment.
- .2 Adhere corner guards to substrate at locations as indicated.

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 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .3 Clean surfaces after installation using manufacturer's written recommended cleaning procedures.
- .4 Final Cleaning: Upon completion, remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 11 - Cleaning.
- .5 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by end cap and corner guard installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 44.40-01, Steel Clothing Locker.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for metal lockers; include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings: type and class of locker, thicknesses of metal, fabricating and assembly methods, assembled banks of lockers, tops, rods, hooks, shelves, bases, trim, numbering, filler panels, end/back panels, doors, handles, locking method, ventilation method, and finishes.
- .4 Samples:
 - .1 Submit duplicate 50 x 50 mm samples of colour and finish on actual base metal.

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 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal lockers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MANUFACTURED UNITS

- .1 Lockers: To CAN/CGSB 44.40, Type 2 - Double tier lockers; Class 2 - A bank of two or more lockers; galvanized cold-rolled steel construction, freestanding configuration.

- .1 Locker unit size: 305 mm (12 inches) wide x 457 mm (18 inches) deep x 914 mm (36 inches) high; overall height of double tiered units 1828 mm (72 inches).
- .2 Steel thickness:
 - .1 Frame: 16 gauge.
 - .2 Body: 24 gauge.
- .3 Assembly: Welded construction.
- .4 Top: Sloped.
- .5 Doors: One-piece double-wall envelope construction, honeycomb core, with integral venting at top and bottom.
 - .1 Inner panel: 24 gauge.
 - .2 Outer panel: 20 gauge.
- .6 Shelves: Fixed, one per locker.
- .7 End panels: Steel with painted finish.
- .8 Base: 20 gauge steel.
- .9 Hinges: 14 gauge steel, 5 knuckle, non-removable pins.
- .10 Hooks: Heavy duty, chrome plated steel, 3 per locker.
- .11 Finish: Powder coat paint.
 - .1 Colour: As selected by Departmental Representative.
- .12 Door handle: Recessed, stainless steel, with 10 gauge hasp and number plates.
- .13 Silencers: Rubber bumpers mounted to inner face of doors, 2 per locker.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates to receive metal lockers are acceptable for product installation in accordance with manufacturer's instructions.
- .2 Inform Departmental Representative of unacceptable conditions.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Assemble and install lockers in accordance with manufacturer's written instructions.
- .2 Securely fasten lockers to grounds and nailing strips.
- .3 Install filler panels (false fronts) where indicated and where obstructions occur.
- .4 Install finished end and back panels to exposed ends and backs of locker banks.
- .5 Install locker numbers.

3.3 ADJUSTING

- .1 Adjust metal lockers for correct function and operation in accordance with manufacturer's written instructions.
- .2 Lubricate moving parts to operate smoothly and fit accurately.

3.4 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by metal locker installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM A1008/A1008M-10, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for firearm lockers; include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings: Dimensions, panels, doors, trim, numbering, locking method, finishes.

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 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect lockers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Steel: To ASTM A1008, commercial quality, cold rolled carbon sheet steel.

2.2 MANUFACTURED UNITS

- .1 Lockers:
 - .1 Assembly: Welded construction.
 - .2 Configuration: 2 openings tall x 1 opening wide.
 - .3 Mounting: Surface.
 - .4 Body:

- .1 Back material, exposed ends: Steel minimum nominal thickness 1.52 mm (16 gauge).
- .5 Doors: Double-wall welded construction, steel nominal thickness minimum 1.21 mm (18 gauge).
 - .1 Door face dimensions: 125-150 mm (5-6 inches) high x 250-275 mm (10-11 inches) wide.
- .6 Hinges: Steel, heavy duty, continuous piano-style hinge; full height of doors.
 - .1 Steel: Nominal minimum thickness 1.52 mm (16 gauge).
 - .2 Weld one of end of each hinge to prevent pin removal.
- .7 Finish: Powder coat paint.
 - .1 Colour: As selected by Departmental Representative from manufacturer's standard range.

2.3 ACCESSORIES

- .1 Locking system: Tube-style locks.
- .2 Number plates: Manufacturer's standard, plastic plates, etched, embossed, or engraved with minimum 13 mm (1/2 inch) high numerals. Affix number plates with two rivets.
- .3 Shelf bottom liners: Neoprene, 3 mm (1/2 inch) thick.
- .4 Door stops: Nylon or polypropylene webbing; provide one per door.

2.4 FABRICATION

- .1 Body: Form backs, tops, bottoms, sides, and intermediate partitions from steel sheet. Make joints between components tight, with no gaps.
- .2 Doors: Form steel into pan shape; form to prevent flexing of door when opening or closing. Weld corners and polish smooth.
- .3 Sand and polish welds smooth.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates to receive firearm lockers are acceptable for product installation in accordance with manufacturer's instructions.
- .2 Inform Departmental Representative of unacceptable conditions.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Assemble and install lockers in accordance with manufacturer's written instructions.
- .2 Set locker plumb, level, and aligned.

- .3 Securely fasten lockers to grounds and nailing strips.

3.3 ADJUSTING

- .1 Adjust lockers for correct function and operation in accordance with manufacturer's written instructions.
- .2 Lubricate moving parts to operate smoothly and fit accurately.

3.4 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by locker installation.

END OF SECTION

Part 1 General

1.1 PERFORMANCE REQUIREMENTS

- .1 Installed roller shade systems to be free from sagging, rippling, curling, cupping, twisting, and telescoping.
- .2 Window coverings required to be consistent with existing building standards. Confirm product details and selections with Departmental Representative before beginning fabrication.

1.2 SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for roller shades. Include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Shop Drawings:
 - .1 Indicate dimensions in relation to window jambs, wiring and operator details, top rail, conditions between adjacent blinds, corner conditions, head anchorage details, hardware, and accessories details.
- .4 Samples:
 - .1 Submit duplicate samples of manufacturer's standard colours and textures for confirmation by Departmental Representative.
 - .1 Submit fascia samples, minimum 150 mm long.
 - .2 Submit samples of shade fabrics, minimum size 150 x 150 mm, showing colour, finish, and texture.

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 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, in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect roller shades from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS AND FABRICATION

- .1 Heavy-duty motor operated horizontal dual roller shade systems.
 - .1 Roller tube: Extruded aluminum with internal ribs, alloy 6063-T5 or 6063-T6; same width as shade band; diameter sufficient to bear weight of shade fabric without deflection.
 - .1 Idler end cap: Spring loaded for ease of roller removal.
 - .2 Brackets: Nickel plated cold rolled steel, for single or double roller tube installations as required.
 - .1 Mounting: Ceiling or wall, confirm on site with Departmental Representative.
 - .3 Bottom bar: External mount, round.
 - .4 Fascia: Extruded aluminum, finish as selected by Departmental Representative from manufacturer's standard range.
 - .5 Sizes: As determined by field measurement.
- .2 Roller shade motor system:
 - .1 Motors: Tubular, asynchronous, thermally protected, with built-in reversible capacitor, brushless, 110V AC, 60Hz, permanently lubricated, single phase.
 - .2 Conceal motors inside shade roller tubes.
 - .3 Provide motors rated at the same nominal speed for all shades in the same room.
 - .4 Sound level: Maximum 44 dBA within 1 metre of roller shade.
 - .5 Control system: Refer to Division 26 – Electrical.
- .3 Blackout fabric: Polyester with foam coating, openness factor 0%. Colour as selected by Departmental Representative from manufacturer's standard range.
- .4 Sunshade fabrics: PVC coated fibreglass, openness factor 3%. Colour as selected by Departmental Representative from manufacturer's standard range.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates and surfaces to receive roller shades are acceptable for product installation in accordance with manufacturer's instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Install roller shades in accordance with manufacturer's instructions.
- .2 Install roller shades level and true.
- .3 Use non-corrosive metal fasteners for installation, concealed in final assembly.

3.3 ADJUSTING

- .1 Adjust shade components for correct function and operation in accordance with manufacturer's written instructions.
- .2 Adjust to provide for quiet operation without binding.
- .3 Adjust shade and shade cloth to hang flat without waves, folds, or distortion.
- .4 Lubricate moving parts to operate smoothly and fit accurately.

3.4 TOLERANCES

- .1 Maximum variation of gap at window opening perimeter: 6 mm per 2.4 m of shade height.

3.5 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Clean exposed surfaces and edges/ends, including metal and shade cloth, using non-abrasive materials and methods recommended by manufacturer. Remove and replace work that cannot be satisfactorily cleaned.
- .4 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by roller shade installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Association of Textile Chemists and Colorists (AATCC)
 - .1 AATCC EP 1, Gray Scale for Color Change, 2012 Edition.
- .2 American National Standards Institute (ANSI)
 - .1 ANSI A208.1-09, Particleboard.
 - .2 ANSI A208.2-09, Medium Density Fiberboard (MDF) for Interior Applications.
- .3 American National Standards Institute/Business and International Furniture Manufacturers Association International (ANSI/BIFMA)
 - .1 ANSI/BIFMA G1-2013, Ergonomics Guideline.
 - .2 ANSI/BIFMA X5.5-2008, Desk Products.
- .4 American National Standard Institute/Human Factors and Ergonomics Society (ANSI/HFES)
 - .1 ANSI/HFES 100-2007, Human Factors Engineering of Computer Workstations.
- .5 American National Standards Institute (ANSI)/National Electrical Manufacturers Association (ANSI/NEMA)
 - .1 ANSI/NEMA LD 3-2005, High-Pressure Decorative Laminates.
- .6 ASTM International
 - .1 ASTM D523-08, Standard Test Method for Specular Gloss.
 - .2 ASTM D3359-09e1, Standard Test Methods for Measuring Adhesion by Tape Test.
 - .3 ASTM D3363-05 (2011)e2, Standard Test Method for Film Hardness by Pencil Test.
 - .4 ASTM D4060-10, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
- .7 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-44.227-2008, Freestanding Office Desk Products and Components.
- .8 Canadian Standards Association (CSA)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part I.
 - .2 CAN/CSA-C22.2 No.203-M91(R2010), Modular Wiring Systems for Office Furniture.

1.2 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 workstations; include product characteristics, performance criteria, physical size, finishes, and limitations.
- .3 Samples:
 - .1 Submit colour sample sheets for surfaces, trim, and accessories.
 - .1 Confirm selections with Departmental Representative prior to fabrication.
- .4 Shop drawings: Submit shop drawings for dispatch consoles at start-up meeting.
 - .1 Indicate console locations, large scale plans, elevations, cross sections, dimensions, and clearances required.

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 workstations, for incorporation into manual.
- .3 Supply part numbers of furniture to allow for replacement of worn or damaged furniture parts.
- .4 Supply instructions detailing procedures for repairing or replacing worn furniture parts.

1.4 QUALITY ASSURANCE

- .1 Manufacturer: Company specializing in manufacture and supply of emergency dispatch workstations, with minimum 5 years' documented experience.
- .2 Dispatch consoles: Products supplied to have documented record of field use by emergency departments or law enforcement agencies.

1.5 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 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 indoors in dry location, and in accordance with manufacturer's recommendations, in clean, dry, well-ventilated area.
 - .2 Store and protect workstation components from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Design of consoles: Comply with ANSI/HFES 100.
- .2 Design console system with independent steel framing, modular and re-configurable to facilitate future retrofitting and reconfiguring without major modifications to structure of independent exterior cladding.
- .3 Use hardware in assembling components and connecting panels that allows for repeated assembly, disassembly and reconfiguration.
- .4 Design console to accommodate various types of computer, communication, display, environmental control, and operator interface devices.
- .5 Design consoles with integrated ventilation and wire management systems.
- .6 Design console to meet functional and ergonomic requirements of working environment in compliance with ANSI/HFES 100 for viewing distance, angle, keyboard height, and knee-well space.
- .7 Design equipment housing to be accessible from front and rear removable panels.
- .8 Ground all metallic components of console.
- .9 Tolerances: 25 mm (1 inch) for nominal dimensions as indicated.
- .10 Supporting metal structures and components: No deflection when normally loaded.

2.2 MATERIALS

- .1 Particleboard: To ANSI A208.1, no added urea formaldehyde, minimum density 720 kg/m³ (45 lb/cu ft).
- .2 MDF (medium density fibreboard) core: To NPA A208.2, Grade 130 or better.
- .3 High pressure decorative laminate (HPDL): To ANSI/NEMA LD 3; colours and patterns as selected by Departmental Representative.
 - .1 60° Specular Gloss (ASTM D523): Maximum 45 units.
 - .2 Abrasion resistance (ASTM D4060): Maximum 0.0409 mg/500 cycles, using CS-10 wheel with 1000 g load.
 - .3 Colour stability (ANSI/NEMA LD 3, Section 3): Change of maximum gray scale 4 contrasts, to AATCC EP 1.
 - .4 Impact resistance (ANSI/NEMA LD 3): No cracking at ball drop height of 762 mm (30 inches).
 - .5 Horizontal surfaces: Horizontal Grade Standard (HGS), 1.2 ± 0.12 mm thick.

- .6 Vertical surfaces: Vertical Grade Standard (VGS), 0.7 mm ± 0.10 mm thick.
- .4 Framing:
 - .1 Allowable framing materials:
 - .1 Steel: To ASTM A653/A653M.
 - .2 Extruded aluminum: To ASTM B221 6061-T5 or -T6 alloy.
 - .2 Finish for metals: Epoxy powder coat paint finish.
 - .1 60° Specular Gloss (ASTM D523): Maximum 45 units.
 - .2 Abrasion resistance (ASTM D4060): Maximum 0.0409 mg/500 cycles, using CS-10 wheel with 1000 g load.
 - .3 Colour stability (ANSI/NEMA LD 3, Section 3): Change of maximum gray scale 4 contrasts to AATCC EP 1.
 - .4 Finish Hardness (ASTM D3363): Minimum 'H' hardness.
 - .5 Paint adhesion (ASTM D3359, Method B): Minimum rating 48.

2.3 FRAME

- .1 Allowable materials for construction:
 - .1 Steel.
 - .2 Aluminum extrusions.
- .2 Horizontal frame members: Include ports within extrusions to allow for flexibility for equipment mounting configuration and re-configuration.
- .3 Leveler legs: Incorporate manually operated levelers to frame, with minimum 25 mm (1 inch) adjustment range; sufficient load bearing capacity to support fully loaded hanging surface and under-mounted work surface storage units.
- .4 Cable management: Fully integrated to frame, accessible from front of console, continuous throughout console layout for uninterrupted cable management.
 - .1 Base structure: minimum two lateral raceways.
 - .2 Base-to-work surface transition: Minimum two vertical raceways.
 - .3 Work surface: One lateral raceway.
 - .4 Provide 50 mm (2 inch) separation between power cables and data cables.

2.4 LIFT SYSTEM

- .1 Lift system for horizontal and vertical work surfaces: Electric drive system, with actuator mechanisms incorporated into and attached directly to structural frame.
 - .1 System to accommodate for differential side-to-side loads to prevent racking and damage to structure.
 - .2 System to be self-correcting in case of loss of synchronization between coordinated actuator mechanisms, preventing binding of lift surface.

- .2 Integrated control panel: Electronic controller for actuator mechanisms, allowing effortless independent height adjustment of keyboard work surface and video monitor support surface. Each mechanism to use two or more framing columns for height adjustments.
 - .1 Incorporate numeric height indicator display to control panel to allow user precise digital replication of surface heights.
- .3 Sound level for lift system in operation: Maximum 50 dBA.
- .4 Drive system safety shut-off feature: Install to horizontal work surface, to entire perimeter and to underside.
- .5 Lift motors: Equip with overload protection with selectable manual/automatic reset.

2.5 HORIZONTAL WORK SURFACE

- .1 Keyboard work surface: One-piece, height adjustable.
 - .1 Maximum deflection to CAN/CGSB 44.227: L/180.
 - .2 Minimum loading: To ANSI/BIFMA X5.5.
 - .1 Minimum capacity: 360 kg (800 lb).
 - .3 Allowable core material:
 - .1 Particleboard, minimum 25 mm (1 inch) thick.
 - .2 MDF, minimum 25 mm (1 inch) thick.
 - .4 Top surface: HPDL.
 - .5 Edging for non-work sides: PVC, minimum 2.5 mm thickness.
 - .6 Keyboard work surface depth: 610 mm (24 inches).
 - .7 Supports: Columns, one on each side of work surface.
 - .8 Continuous height adjustment:
 - .1 Plane of adjustment: Perpendicular to display monitor faces.
 - .2 Surface height range: To ANSI/HFES 100.
 - .9 Main work surface to accommodate minimum:
 - .1 Two keyboards.
 - .2 Two computer mice.
 - .3 One telephone set, 500 x 200 mm (20 x 8 inches).
 - .10 Work-side nosing: Ergonomic soft material nosing at console edge that contacts operator's arms; cleanable with commercially available cleaners and sanitizers.

2.6 VERTICAL SUPPORT SURFACE

- .1 Video monitor support surfaces: One-piece, to support display devices, height adjustable.
 - .1 Width: Minimum capacity for six 24 inch LCD monitors end-to-end without extending over edge of surface.

- .2 Continuous height adjustment:
 - .1 Height range to ANSI/HFES 100.
- .3 Supports: Columns, one on each side of work surface.
- .4 Monitor mounting arms: Adjustable for flexibility in mounting configurations, including vertically stacked monitor pairs; include minimum 6 mounting arms per console.
 - .1 Adjustment: Single control.
 - .2 Articulation: Tilt, rotate, forward/back, and raise/lower capabilities.
 - .3 Provide capability for vertically stacked monitors.
- .5 Fabricate with electromechanically adjustable columns with minimum 160 kg (350 lb) load capacity per column.

2.7 ENVIRONMENTAL CONTROL SYSTEM

- .1 Ventilation control unit with heater.
 - .1 Heater: Forced air, directional, adjustable up to 1150 watts, mounted under work surface. Free-standing heat panels are not acceptable.
 - .2 Fans: Protected to prevent obstruction by foreign objects.
 - .3 Diffusers: Low-profile, directional, adjustable, mounted to top of keyboard surface; flush to desk surface when in closed position.
 - .4 Operating sound level: Maximum 50 dBA.
 - .5 Controls: Integrated unit, with status lights indicating 'HEAT ON' and 'FAN ON'.
 - .6 Power cord for heater: Non-standard colour, or labelling indicating cord not to be plugged into uninterruptable power supplies (UPS).
 - .7 Electrical overload protection: Manually resettable.
- .2 Task light fixtures: LED, dimmable and adjustable, to provide lighting coverage to entire work surface.

2.8 EQUIPMENT MOUNTING SYSTEM

- .1 Two trays, mounted within base of console, raised above floor, to accommodate:
 - .1 6 full sized computer towers – 3 on each side of console.
 - .2 Other communication, display, and operator interface devices.

2.9 PARTITION SYSTEM

- .1 Panels:
 - .1 Cladding panels: Fabric-wrapped panels with NRC ≥ 0.50 ; optional clear glass section at top of partition.
 - .1 Attachment to frame: Concealed.
 - .2 Core: 19 mm (3/4 inch) solid composite.
 - .3 Edges: PVC, post-applied, complementary colour to faces of panels.

- .2 Access panels: Front and back, removable and replaceable without tools.
- .3 End gables:
 - .1 Core: Particle board, minimum 25 mm (1 inch) thick.
 - .2 Face: High pressure decorative laminate (HPDL).
 - .3 Fastening: Mechanical, easily reconfigurable without site cutting, drilling, or machining. Wood screws are not acceptable.
- .4 Panels: stable, stand straight and plumb when interconnected.
 - .1 Height variance of same height panels when interconnected: 3 mm maximum.
- .2 Electrical system: To CAN/CSA-C22.2, No.203, and UL listed as "Manufactured Wiring System".
 - .1 Construct electrical system of modular components and capable of providing power only at needed locations, of being rearranged without altering or disassembling panel system.
 - .1 Provide receptacle accessible at work surface height.
 - .2 PDUs: Provide three, independent of each other.
 - .1 Rating: 120 VAC at 15 amps each.
 - .2 Provide power cords, minimum 6 metre (20 foot) long, with NEMA 5-15 plug.
 - .3 Outlets: NEMA 5-15R, minimum 8 receptacles/PDU.
 - .4 Independent voltage and current display.
 - .5 15 amp breakers, manually resettable.
 - .6 Design to eliminate electrocution hazard due to improperly seated transformer plugs.
 - .7 Fasten PDUs and associated outlets securely to console with purpose-made hardware. Double-sided tape is not permitted.
- .3 Data Distribution Panel: Three separate USB 3.0/2.0 compatible distribution hubs.
 - .1 Panels: Minimum 4 powered USB connectors per hub.
 - .2 Number cables and connectors for easy identification.
 - .3 Integrate cabling for data distribution hubs to desktop cable management system; terminate in CPU equipment base tray.

2.10 TRAINER PODIUM

- .1 Fabricate trainer podium with same materials and construction as for dispatch consoles. Include:
 - .1 Accommodation for two 19 inch LCD monitors, PC-style computer tower, keyboard, and mouse.
 - .2 12 RU rotatable server rack.
 - .3 Shelving for large binders.

- .4 Video control for TV or projector.
- .5 Sound system controls.
- .6 Lighting controls for training area.

2.11 FABRICATION

- .1 Fabricate components to be uniform in quality, style, and material, free from defects that may affect appearance, serviceability, and safety.
- .2 Welds: Structurally sound, free of, clean, smooth and uniform in appearance. Ensure welds are free of cracks and surface voids, scale, flux, trapped foreign material or inclusions.
- .3 Fabricate consoles to be free of unfinished edges and surfaces.
- .4 Safety:
 - .1 Fabricate consoles with fixed, moveable, and adjustable parts that cannot be unintentionally loosened or dislodged.
 - .2 Fabricate edges, corners, and regularly contacted points of console and access panel areas to be free of sharp edges that may cause injury.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates are acceptable for installation of consoles in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Install consoles at locations shown on drawings.
 - .1 Position accurately, level, plumb, and straight.

3.3 FINISH REPAIRS

- .1 Touch up finishes damaged during installation.

3.4 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 11 - Cleaning. 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 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect consoles from damage until final inspection.
- .2 Protect installed consoles from damage during construction.
- .3 Repair damage to adjacent materials caused by console installation.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum 2007).
 - .2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
 - .3 LEED Canada 2009 for Design and Construction-2010, LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide.
 - .4 LEED Canada for Existing Buildings, Operations and Maintenance-2009, LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.

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 fire protection devices and 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 Province where work is taking place.
 - .2 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

- .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.
- .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer content, and total cost of materials for project.
- .3 Regional Materials: submit evidence that project incorporates required percentage 50% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

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 fire protection devices and equipment for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .5 Approvals:
 - .1 Submit [2] copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.

- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Departmental Representative will provide [1] set of reproducible mechanical drawings. Provide sets of [white] prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .8 As-Built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 Maintenance Material Submittals

- .1 Submit in accordance with Section [01 78 00 - Closeout Submittals].
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials indoors off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 NOT USED.

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 Departmental Representative.

3.2 Painting Repairs And Restoration

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 System Cleaning

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

3.4 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .1 Testing to be witness by Authority Having Jurisdiction.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit

Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 Demonstration

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems.
 - .1 Air compressor.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio-visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling, reuse in accordance with 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 Protection

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

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 National Fire Prevention Association (NFPA)
 - .1 NFPA 13-Latest Edition, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-Latest Edition, Standard for the Installation of Standpipe and Hose Systems
 - .3 NFPA 25-Latest Edition, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province where work is taking place.
 - .2 Indicate:
 - .1 Materials.
 - .2 Finishes.
 - .3 Method of anchorage
 - .4 Number of anchors.
 - .5 Supports.
 - .6 Reinforcement.
 - .7 Assembly details.
 - .8 Accessories.
- .4 Samples:
 - .1 Submit samples of following:
 - .1 Each type of sprinkler head.
 - .2 Signs.
- .5 Test reports:
 - .1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Certificates:

- .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .7 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.
- .8 Field Quality Control Submittals:
 - .1 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 Closeout Submittals

- .1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals in accordance with ANSI/NFPA 20.
- .2 Manufacturer's catalogue Data, including specific model, type, and size for:
 - .1 Pipe and fittings.
 - .2 Alarm valves.
 - .3 Valves, including gate, check, and globe.
 - .4 Water motor alarms.
 - .5 Sprinkler heads.
 - .6 Pipe hangers and supports.
 - .7 Pressure or flow switch.
 - .8 Fire department connections.
 - .9 Excess pressure pump.
 - .10 Mechanical couplings.
- .3 Drawings:
 - .1 Sprinkler heads and piping system layout.
 - .1 Prepare 760 mm by 1050 mm detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
 - .2 Show data essential for proper installation of each system.
 - .3 Show details, plan view, elevations, and sections of systems supply and piping.
 - .4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.
 - .2 Electrical wiring diagrams.
- .4 Design Data:
 - .1 Calculations of sprinkler system design.
 - .2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.
- .5 Field Test Reports:
 - .1 Preliminary tests on piping system.
- .6 Records:
 - .1 As-built drawings of each system.
 - .1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.

- .2 Submit 760 mm by 1050 mm drawings on reproducible Mylar film with title block similar to full size contract drawings.
 - .7 Operation and Maintenance Manuals:
 - .1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for underground and aboveground piping and other documentation for incorporation into manual in accordance with NFPA 13.
- 1.4 Quality Assurance**
 - .1 Qualifications:
 - .1 Installer: company or person specializing in wet sprinkler systems with documented experience.
 - .2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.
- 1.5 Maintenance Material Submittals**
 - .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide spare sprinklers and tools in accordance with NFPA 13.
- 1.6 Delivery, Storage And Handling**
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
 - .3 Storage and Protection:
 - .1 Store materials in dry location indoors.
 - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.
 - .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, packaging materials padding, crates, in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- PART 2 PRODUCTS**
 - 2.1 Design Requirements**
 - .1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, by hydraulic calculations for uniform distribution of water over design area for ordinary hazard occupancy.
 - .2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

- .3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.
- .4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.
- .5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.
- .6 Design systems for earthquake protection for buildings in seismic zones [3] and [4], and only essential and high risk buildings in seismic zone [2].
- .7 Location of Sprinkler Heads:
 - .1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13 for ordinary hazard occupancy.
 - .2 Uniformly space sprinklers on branch.
- .8 Water Distribution:
 - .1 Make distribution uniform throughout the area in which sprinkler heads will open.
 - .2 Discharge from individual heads in hydraulically most remote area to be [100] % of specified density.
- .9 Density of Application of Water:
 - .1 Size pipe to provide specified density when system is discharging specified total maximum required flow.
 - .2 Application to horizontal surfaces below sprinklers shall be 0.8lpm per m2.
- .10 Sprinkler Discharge Area:
 - .1 Area: hydraulically most remote area as defined in NFPA 13.
- .11 Outside Hose Allowances:
 - .1 Include allowance in hydraulic calculations of 946lpm for outside hose streams.
- .12 Friction Losses:
 - .1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.
- .13 Water Supply:
 - .1 Conduct flow and pressure test of water supply in vicinity area of project to obtain criteria for basis of design or Confirm pressure reading on existing pressure gauges of existing sprinkler system.

2.2 Sustainable Requirements

- .1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .2 Grooved couplings and fittings made from minimum 90% recycled metal.

2.3 Above Ground Piping Systems

- .1 Provide fittings for changes in direction of piping and for connections.

- .1 Make changes in piping sizes through tapered reducing pipe fittings, bushings will not be permitted.
- .2 Perform welding in shop; field welding will not be permitted.
- .3 Conceal piping in areas with suspended ceiling.

2.4 Pipe, Fittings And Valves

- .1 Pipe:
 - .1 Ferrous: to NFPA 13.
- .2 Fittings and joints to NFPA 13:
 - .1 Ferrous: screwed, welded, flanged or roll grooved.
 - .1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.
 - .2 Provide welded, threaded, grooved-end type fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.
 - .3 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
 - .4 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 38mm and larger.
 - .5 Fittings: ULC approved for use in wet pipe sprinkler systems.
 - .6 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.
 - .7 Side outlet tees using rubber gasketed fittings are not permitted.
 - .8 Sprinkler pipe and fittings: metal.
- .3 Valves:
 - .1 ULC listed for fire protection service.
 - .2 Gate valves: open by counter-clockwise rotation.
 - .3 Check valves: flanged clear opening swing or spring actuated check type with flanged inspection and access cover plate for sizes 10cm and larger.
 - .4 Provide gate valve in piping protecting machine rooms, machinery spaces elevator hoist way.
- .4 Pipe hangers:
 - .1 ULC listed for fire protection services in accordance with NFPA.

2.5 Sprinkler Heads

- .1 General: to NFPA 13 and ULC listed for fire services.
- .2 Sprinkler Head Type:
 - .1 Type A: upright bronze.
 - .2 Type B: pendant chrome link and lever type.
 - .3 Type C: pendant chrome glass bulb type.
 - .4 Type D: recessed chrome polished glass bulb type with ring and cup.
 - .5 Type E: flush polished chrome link and lever type.

- .6 Type F: side wall polished chrome link and lever type.
- .3 Provide nominal 1.2cm orifice sprinkler heads.
 - .1 Release element of each head to be of intermediate temperature rating or higher as suitable for specific application.
 - .2 Provide polished chromium-plated finish on copper alloy ceiling plates, chromium-plated pendent sprinklers below suspended ceilings.
 - .3 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.
 - .4 Provide dry barrel type sprinkler heads as indicated.
 - .5 Deflector: not more than 75mm below suspended ceilings.
 - .6 Ceiling plates: not more than 25mm deep.
 - .7 Ceiling cups: not permitted.

2.6 Supervisory Switches

- .1 General: to NFPA 13 and ULC listed for fire service.
- .2 Valves:
 - .1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.
- .3 Pressure or flow switch type:
 - .1 With normally open and normally closed contacts and supervisory capability.
 - .2 Provide switch with circuit opener or closer for automatic transmittal of alarm over facility fire alarm system.
 - .3 Connect into building fire alarm system.
 - .4 Connection of switch: Section 28 31 00.01 Multiplex Fire Alarm System.
 - .5 Alarm actuating device: mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and instantly recycle.
- .4 Pressure alarm switch:
 - .1 With normally open and normally closed contacts and supervisory capability.

2.7 Pressure Gauges

- .1 ULC listed and to Section 23 05 19.01 - Thermometers and Pressure Gauges - Piping Systems.
- .2 Maximum limit of not less than twice normal working pressure at point where installed.

2.8 Pipe Sleeves

- .1 Provide pipe sleeves where piping passes through walls and floors.
- .2 Secure sleeves in position and location during construction.
- .3 Provide sleeves of sufficient length to pass through entire thickness of walls, floors.
- .4 Provide 2.5cm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.
 - .1 Firmly pack space with mineral wool insulation.

- .2 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass, provide mechanically adjustable segmented elastomeric seal.
- .3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.
- .5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:
 - .1 Provide ductile-iron or hot-dip galvanized steel.
 - .2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.
- .6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:
 - .1 Provide 0.61mm thick galvanized steel sheet.

2.9 Escutcheon Plates

- .1 Provide split hinge type metal plates for piping passing through floors, walls, ceilings in exposed spaces.
- .2 Provide polished chromium-plated finish on copper alloy plates in finished spaces.
- .3 Provide paint finish on metal plates in unfinished spaces.

2.10 Inspector's Test Connection

- .1 Locate inspector's test connection at hydraulically most remote part of each system, provide test connections approximately 3m above floor for each sprinkler system or portion of each sprinkler system equipped with alarm device.
- .2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.
- .3 Provide discharge orifice of same size as corresponding sprinkler orifice.

2.11 Signs

- .1 Attach properly lettered and approved metal signs to each valve and alarm device to NFPA 13.
- .2 Permanently fix hydraulic design data nameplates to riser of each system.

2.12 Spare Parts Cabinet

- .1 Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each alarm valve. Number and types of extra sprinkler heads as specified in NFPA 13.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Install, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

3.3 Pipe Installation

- .1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.
- .2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.
- .3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.
- .4 Inspect piping before placing into position.

3.4 Electrical Connections

- .1 Provide electrical work associated with this section under Section 26 05 00 - Common Work Results for Electrical.
- .2 Provide fire alarm system under Section 28 31 00.01 Multiplex Fire Alarm System.
- .3 Provide control and fire alarm wiring, including connections to fire alarm systems, in accordance with National Electrical Code.
- .4 Provide wiring in rigid metal conduit or intermediate metal conduit.

3.5 Disinfection

- .1 Disinfect new piping and existing piping.
- .2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.
- .3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.
- .4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.6 Connections To Existing Water Supply Systems

- .1 Notify Contracting Officer in writing at least 15 days prior to connection date.
- .2 Use tapping or drilling machine valve and mechanical joint type sleeves for connections to be made under pressure.
- .3 Bolt sleeves around main piping.
- .4 Bolt valve to branch connection. Open valve, attach drilling machine, make tap, close valve, and remove drilling machine, without interruption of service.
- .5 Furnish materials required to make connections into existing water supply systems, and perform excavating, backfilling, and other incidental labour as required.

3.7 Field Painting

- .1 Clean, pre-treat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.
- .2 Apply coatings to clean, dry surfaces, using clean brushes.
- .3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.

- .4 Immediately after cleaning, provide metal surfaces with 1 coat of pre-treatment primer applied to minimum dry film thickness of 0.3 mil, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0 mil.
- .5 Shield sprinkler heads with protective covering while painting is in progress.
- .6 Upon completion of painting, remove protective covering from sprinkler heads.
- .7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.
- .8 Provide primed surfaces with following:
 - .1 Piping in Finished Areas:
 - .1 Provide primed surfaces with 2 coats of paint to match adjacent surfaces.
 - .2 Provide valves and operating accessories with 1 coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil.
 - .3 Provide piping with self-adhering red plastic bands spaced at maximum of 6m intervals throughout piping systems.
 - .2 Piping in Unfinished Areas:
 - .1 Provide primed surfaces with one coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil in spaces where walls or ceiling are not painted or not constructed of a prefinished material, pipe chases, attic spaces, spaces above suspended ceilings, crawl spaces, mechanical equipment room.
 - .2 Provide piping with self-adhering red plastic bands spaced at maximum of 6m intervals.

3.8 Field Quality Control

- .1 Site Test, Inspection:
 - .1 Perform test to determine compliance with specified requirements in presence of Departmental Representative.
 - .2 Test, inspect, and approve piping before covering or concealing.
 - .3 Preliminary Tests:
 - .1 Hydrostatically test each system at 200 psig for a 2 hour period with no leakage or reduction in pressure.
 - .2 Flush piping with potable water in accordance with NFPA 13.
 - .3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.
 - .4 Test alarms and other devices.
 - .5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.
 - .4 Formal Tests and Inspections:
 - .1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.
 - .2 Submit written request for formal inspection at least 15 days prior to inspection date.
 - .3 Repeat required tests as directed.

- .4 Correct defects and make additional tests until systems comply with contract requirements.
 - .5 Furnish personnel equipment, instruments, appliances, connecting devices for tests.
 - .6 Authority of Jurisdiction, will witness formal tests and approve systems before they are accepted.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .3 Site Tests:
 - .1 Testing to be witnessed by authority having jurisdiction.
 - .2 Develop, with Departmental Representative assistance, detailed instructions for O & M of this installation.

3.9 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling, reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA13-Latest Edition, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 25-Latest Edition, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN4 S543-[M1984], Standard for Internal Lug Quick Connect Coupling for Fire Hose.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems, applicable series designation or style and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province where work is taking place.
- .4 Samples:
 - .1 Submit samples of following:
 - .1 Each type of sprinkler head.
 - .2 Signs and valve tags.
- .5 Test reports:
 - .1 Submit certified test reports for packaged fire pumps from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Test each pump/driver package at factory to provide detailed performance data and to demonstrate compliance with NFPA and specification. Submit certified test curves for approval of Departmental Representative.
 - .3 Test hydrostatically to meet requirements of fire protection system to which it will be connected.
- .6 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .7 Manufacturers' Instructions:
 - .1 Instructions: provide manufacturer's installation instructions.
- .8 Field Quality Control Submittals:
 - .1 Manufacturer's Field Reports: submit manufacturer's field reports specified.

1.3 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Provide detailed hydraulic calculations including: summary sheet, Contractor's Material and Test Certificate for aboveground piping, as well as other deliverables for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, in accordance with NFPA 13.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Installer: company or person specializing in dry sprinkler systems with documented experience.
- .2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.5 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide spare sprinklers and tools in accordance with NFPA 13.

1.6 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements].
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer and return of padding, pallets, crates, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Engineering Design Criteria

- .1 Design system in accordance with NFPA 13, using following parameters:
 - .1 Hazard:
 - .1 To suit occupancy as indicated.
 - .2 Pipe size and layout:
 - .1 Hydraulic design.
 - .2 Sprinkler head layout: to NFPA 13 .
 - .3 Water supply:
 - .1 Conduct flow and pressure test of water supply in vicinity of project or confirm pressure reading from existing pressure gauges of existing

sprinkler to obtain criteria for bases of design in accordance with NFPA 13.

.2 Base design on NFPA13.

.4 Zoning:

.1 System zoning as indicated.

2.2 Pipe, Fittings And Valves

.1 Pipe:

.1 Ferrous: to NFPA 13.

.2 Fittings and joints to NFPA 13:

.1 Ferrous: roll grooved, screwed, welded, flanged.

.1 Grooved joints designed with two ductile iron housing segments, flush seal gasket for dry service, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.

.3 Auxiliary valves:

.1 ULC listed for fire protection service.

.2 Up to NPS 2: bronze, screwed ends, grooved, OS&Y gate.

.3 NPS 2 1/2 and over: cast or ductile iron, flanged or roll grooved ends, indicating butterfly valve.

.4 Swing or spring-actuated check valves.

.5 Ball drip.

.6 Tamper devices wired back to fire alarm panel.

.4 Pipe hangers:

.1 ULC listed for fire protection services.

2.3 Sprinkler Heads

.1 General: to NFPA 13 and ULC listed for fire services.

.2 Refer also to Section 21 13 13 for sprinkler head types.

2.4 Auxiliary Supervisory Switches

.1 General: to NFPA 13 and ULC listed for fire service.

.2 Valves:

.1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.

.3 Flow switch type:

.1 With normally open and normally closed contacts and supervisory capability.

.4 Pressure alarm switch:

.1 With normally open and normally closed contacts and supervisory capability.

2.5 Fire Department Connection

.1 Existing.

2.6 Pre-Action/Deluge Alarm Valve

- .1 ULC listed.
- .2 Cast or ductile iron, flanged or grooved end type, sized to suit water main.
- .3 Components:
 - .1 Accelerator.
 - .2 Air maintenance device with low pressure alarm.
 - .3 Alarm pressure switch with supervisory capability.
 - .4 Test valve and associated piping.
 - .5 Drain valve.
 - .6 Electrical tripping device.
 - .7 Shut off valve - OS&Y with tamper-proof device wired back to fire alarm panel.
- .4 Provide valve complete with internal components that are replaceable without removing valve from installed position.

2.7 Compressed Air Supply

- .1 Automatic Air Compressor.
- .2 ULC listed.
- .3 Capacity:
 - .1 To restore normal air pressure in system within 30 minutes.
 - .2 To provide air pressure in accordance with instruction sheet furnished with pre-action valve.
- .4 Piping: ferrous, NPS 3/4 screwed joints and fittings, to NFPA 13.

2.8 Pressure Gauges

- .1 ULC listed and to Section 23 05 19 - Thermometers and Pressure Gauges - Piping Systems.
- .2 Maximum limit of not less than twice normal working pressure at point where installed.

2.9 Relief Valve

- .1 ULC listed.

2.10 Spare Parts Cabinet

- .1 For storage of maintenance materials, spare sprinkler heads and special tools.
- .2 Construct to sprinkler head manufacturers standard.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Install, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.
- .2 Testing to be witnessed by authority having jurisdiction.
- .3 Install spare parts cabinet as indicated.
- .4 Pressure gauges:
 - .1 Location:
 - .1 On water side and air side of pre-action valve.
 - .2 At air receiver.
 - .3 In each independent pipe from air supply to dry pipe valve.
 - .4 At exhausters and accelerators.
 - .2 Install to permit removal.
 - .3 Locate so as not subjected to freezing.
- .5 Valve identification:
 - .1 Identify drain valve, by-pass valves and main shut-off valve and all auxiliary valves.

3.3 Field Quality Control

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 Section 22.

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 plumbing fixtures and devices, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province where work is taking place.
 - .2 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.
 - .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer content, and total cost of materials for project.
 - .3 Regional Materials: submit evidence that project incorporates required percentage 50% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

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 incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
 - .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
 - .7 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.

- .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 Maintenance Material Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer and return of packaging materials, crates, padding, pallets, as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used.

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 Painting Repairs And Restoration

- .1 Do painting in accordance with Section [09 91 00 - Painting].
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 System Cleaning

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

3.4 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 -ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 Demonstration

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to equipment and systems as required.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio-visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.

- .6 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling and reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 Protection

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

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Material and installation of pipe work in general.

1.2 References

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B24, Cast Copper Alloy Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B39, Malleable Iron Threaded Pipe Unions.
 - .3 ANSI/ASME B42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
- .2 American Society for Testing and Materials (ASTM)
- .3 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.9 – Building Services Piping.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

PART 2 PRODUCTS

2.1 General

- .1 Installations shall include all devices, attachments, equipment, components and piping necessary to form a complete working system to code requirements.

2.2 Valves

- .1 Refer to the specific pipe specification sections for valve types.
- .2 All valves of one type (e.g. gate valves) must be of one manufacturer. Ensure that working pressure, size and manufacturer's name are cast or stamped into the body of each valve.
- .3 Use O. S. & Y. design on all valves 100 mm and larger unless specifically noted otherwise.
- .4 Provide hand wheels on valves 75mm and larger accessible for operation.

2.3 Strainers

- .1 Provide Y-type strainers where, indicated on the drawings and where specified herein, in piping system, full size of the connected piping ahead of each pump, control valve, meter, etc. Install bucket or basket strainers only where indicated on the drawings.

- .2 All strainers shall have the same end connections and working pressure as the attached piping is specified.
- .3 Use monel screens with a reinforced edge. Perforations shall be 0.8 mm for water and 3.2 mm ahead of pumps.
- .4 Provide 20 mm blow-off lines with ball valves, piped directly to drain on all strainers over 50 mm.

2.4 Dielectric Pipe Fittings /Unions

- .1 Dielectric fittings factory certified to withstand a minimum of 600 volts on a dry line with no flashover. Unions rated at 1.7 MPa conforming to ANSI B16.39. Flanged fittings rated at 1.2 MPa conforming to ANSI B16.24 (bronze) and B16.42 (iron).

2.5 Pipe Sleeves And Seals

- .1 Where piping penetrates below grade walls or floors:
 - .1 Seal: modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening complete with 316 stainless steel fasteners. Seal elements shall be sized and selected per manufacturer's recommendations and be suitable for the required fire-resistance rating and anticipated environmental conditions.
 - .2 Sleeve: custom-sized molded HDPE sleeves matched to the mechanical seal dimensions complete with reinforcing ribs, end caps, and integrally formed hollow water stop having a minimum outside diameter 100 mm larger than the diameter of the sleeve itself and allowing 13 mm movement between wall forms to resist pour forces.
- .2 Elsewhere: Schedule 40 black steel pipe sleeve.
- .3 All sleeves and floor penetrations to be water-tight.

PART 3 EXECUTION

3.1 Connections To Equipment

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Provide valves and either unions, flanges or grooved joint couplings to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping is subject to movement.

3.2 Clearances

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, and components.

3.3 Drains

- .1 Arrange pipe and fittings to ensure complete drainage.
- .2 Install drain valve at low points in piping systems, at equipment and at sectional/floor isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Provide air vents as required to assist in draining the piping.
- .5 Drain valves: Ball valves unless otherwise approved, NPS 3/4 minimum. Provide hose end male thread, cap and chain where not piped to drain.

3.4 Dielectric Couplings

- .1 General: Compatible with system, to suit pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: Isolating flanges.
- .5 Rated to 150C.

3.5 Pipework Installation

- .1 Install exposed piping, equipment, rectangular cleanouts and similar items approximately as shown, parallel or perpendicular to building lines and as close to the structure as possible.
- .2 Conceal all piping except where otherwise approved. Install concealed piping to minimize furring space, maximize headroom, and conserve space.
- .3 Exposed piping must be carefully installed to be pleasing to the eye and meet the Departmental Representative requirements.
- .4 Install all pipe mounted control devices, such as control valves and wells.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Use only eccentric reducing fittings at pipe size changes, installed with the piping in line at the top to ensure positive drainage and venting.

- .8 Use only long radius welding or soldered fittings in expansion loops, not screwed fittings.
- .9 American National Taper pipe thread must be used for all thread connections. Remove burrs and chips and ream or file the pipe ends out to size of bore.
- .10 Leave not more than 2 threads exposed on threaded joints when made up.
- .11 Screwed fittings jointed with Teflon tape.
- .12 Do not use:
 - .1 close nipples.
 - .2 threaded protectors as couplings.
 - .3 direct welded or screwed connections to valves, equipment or other apparatus.
- .13 Protect openings against entry of foreign material.
- .14 Ream pipes, remove scale and other foreign material before assembly.
- .15 Slope piping for positive drainage and venting.
- .16 Arrange piping to permit flushing.
- .17 Group piping, wherever possible.
- .18 Provide anchors and sway braces to Departmental Representative approval.
- .19 Provide for thermal expansion.
- .20 Provide for movement due to seismic events as required by the NBC.

3.6 Expansion Of Piping

- .1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to the building and equipment. Where pipe runs past building expansion joints, provide expansion compensation.
- .2 Only major expansion configurations and fittings have been detailed on the drawings. Provide all required additional compensators, loops and swing connections as specified herein, and in accordance with good trade practice.
- .3 Use swing connections with a minimum of 3 elbows (i.e. four fittings including the tee) where required. These swing connections are not always shown on the piping drawings for reasons of clarity; they must however, be installed. Where close tolerances do not permit the installation of a complete swing connection, consult the Engineer prior to the closing of tender.
- .4 Install expansion loops cold spring 50 percent of the calculated expansion.
- .5 Schedule for Expansion Loops:
 - .1 Maximum Distance between Anchors:
 - .1 Domestic Hot Water; copper 30 m, steel 45 m.

.2	Loop Size Required:	
	Pipe Size NPS	Loop Size (m)
	3/4	1.22
	1	1.27
	1-1/4	1.32
	1-1/2	1.37
	2	1.42
	2-1/2	1.53
	3	1.68
	4	1.98

- .6 If the length between anchors is 50% of the maximum listed above, then the loop can be reduced to 67% of that listed.

- .7 Loops shall be located midway between guides.

3.7 Pipe Guides

- .1 Provide alignment guides where required for proper operation of the system.

3.8 Pipe Anchors

- .1 Provide substantial pipe anchors. Anchors shall be suitably attached to the structure and the pipe to prevent movement.

3.9 Pipe Sleeves And Seals

- .1 General: Install where pipes pass through masonry structures, concrete structures, beams, fire rated assemblies, and elsewhere as indicated. Be responsible for maintaining the integrity of the building envelope when making penetrations. Enlist the services of qualified trade(s) to make openings in, and/or repairs to, building envelope.
- .2 Sleeve Sizes:
- .1 Walls and beams: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .2 Floors: 20 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .3 Sleeve Installation:
- .1 Concrete walls, masonry walls, beams, and concrete floors on grade: Terminate flush with finished surface.
- .2 Other floors:
- .1 Terminate 50 mm above finished floor.
- .2 Adjust as necessary to accommodate the requirements of through-penetration fire-stopping systems.
- .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .4 Sealing:

- .1 Foundation walls and below grade floors: Fire retardant, waterproof, modular mechanical seal.
- .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
- .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
- .4 Ensure no contact between copper pipe or tube and sleeve.

3.10 Escutcheons

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or stainless steel.
- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.11 Preparation For Firestopping

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Firestopping.
- .2 Uninsulated unheated pipes not subject to movement: No special preparation.
- .3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.12 Flushing Out Of Piping Systems

- .1 In accordance as specified in relevant sections of Division 22.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant sections of Division 22.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.13 Pressure Testing Of Equipment And Pipework

- .1 Advise Departmental Representative 48-hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Division 22 where specified, otherwise test to requirements of ASME B31.9.
- .3 Test all piping, with the exception of atmospheric vents and sanitary piping, hydraulically to 1½ times the operating pressure but not less than 860 kPag.
- .4 Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

- .1 Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
- .2 Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- .3 Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 30 kPa (10 ft WC). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- .4 Prepare reports for tests and required corrective action.
- .5 Prove piping with less than 14 kPa pressure drop and no visible leakages for a period of 24 hours with a hydraulic test.
- .6 Test all sanitary piping in accordance with the applicable Plumbing code.
- .7 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or test media.
- .8 Conduct tests in presence of Departmental Representative.
- .9 Pay costs for testing, repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .10 Insulate or conceal work only after approval and certification of tests by Departmental Representative. Test underground piping prior to backfilling.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 This Section includes requirements for selective demolition and removal of plumbing, sprinkler systems and related mechanical components and incidentals required to complete work described in this Section ready for new construction.

1.2 Related Requirements

- .1 Section 02 41 23- Demolition and Removals
- .2 Section 02 82 10- Asbestos Abatement Type 1 Precautions
- .3 Section 02 82 11- Asbestos Abatement Type 2 Precautions

1.3 Reference Standards

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

1.4 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 Departmental Representative 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 the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.5 Action And Informational Submittals

- .1 Action Submittals: Provide the following in accordance with Section 01 33 00– Submittal Procedures before starting work of this Section:
 - .1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in

accordance with Section 01 74 21– Construction/Demolition Waste Management and Disposal.

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

1.6 Administrative Requirements

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.
- .2 Scheduling: Account for Departmental Representatives continued occupancy requirements during selective demolition with Section 02 41 23, Section 02 82 10, Section 02 82 11 and schedule staged occupancy and worksite activities as a defined Critical Path item in accordance with Section 01 32 16– Construction Progress Schedule.

1.7 Site Conditions

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition at time of site examination before tendering].
- .2 Existing Hazardous Substances: Departmental Representative performed a hazardous substances assessment and it is not expected that hazardous substances will be encountered in the Work.
 - .1 Hazardous substances will be removed by a hazardous abatement specialist engaged by the Departmental Representative before start of the Work.
- .3 Existing Hazardous Substances: Departmental Representative has performed a hazardous substances assessment and identified materials requiring abatement as follows:
 - .1 Hazardous substances are as defined in the Hazardous Products Act.
 - .2 Hazardous substances will be removed by the Contractor as a part of the Contract before starting Work in accordance with work results described in Related Requirements listed above.
- .4 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in the Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform the 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 the Hazardous Products Act.
 - .3 Stop work in the area of the 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 Departmental Representative under a separate contract or as a change to the Work.
 - .6 Proceed only after written instructions have been received from Departmental Representative.

PART 2 PRODUCTS

2.1 Repair Materials

- .1 General Patching and Repair Materials: Refer to Section 02 41 23 for listing of patching and repair materials incidental to removal or demolition of components associated with work of this Section.
- .2 Plumbing Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.
- .3 Firestopping Repair Materials: Use firestopping materials compatible with existing firestopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

2.2 Salvage And Debris Materials

- .1 Material Ownership: Demolished materials become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Departmental Representative property].
- .2 Salvaged Materials: Carefully remove materials designated for salvage and store in a manner to prevent damage or devaluation of materials in accordance with Section 02 41 23.

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 must 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 the 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: Coordinate requirements of this Section with information contained in Section 02 41 23 and as follows:
 - .1 Disconnect and cap mechanical services in accordance with requirements of local Authority Having Jurisdiction.
 - .2 Do not disrupt active or energized utilities without approval of the Departmental Representative.
 - .3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.
 - .4 Demolish parts of existing building to accommodate new construction and remedial work as indicated.
 - .5 At end of each day's work, leave worksite in safe condition.
 - .6 Perform demolition work in a neat and workmanlike manner:
 - .1 Remove any tools or equipment after completion of work and leave site clean and ready for subsequent renovation work.
 - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

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 except where explicitly noted otherwise for materials being salvaged for re use in new construction in accordance with Section 02 42 23.
- .2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances in accordance with requirements of Section 02 82 10 and Section 02 82 11.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 Section 22.

1.2 Reference Standards

- .1 American Society of Mechanical Engineers International (ASME)
 - .1 ANSI/ASME B16.15-13, Cast Copper Alloy Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18-12, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22-13, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24-11, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .5 ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .6 ASME B31.9-14, Building Services Piping.
 - .7 ASME B36.19M-04, Stainless Steel Pipe.
- .2 ASTM International
 - .1 ASTM A182/A 182M-16, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - .2 ASTM A269-15a, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .3 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .4 ASTM A312/A312M-16, Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - .5 ASTM A351/A351M-16, Castings, Austenitic, for Pressure Containing Parts.
 - .6 ASTM A403/A403M-16, Wrought Austenitic Stainless Steel Piping Fittings.
 - .7 ASTM A536-84 (2014), Standard Specification for Ductile Iron Castings.
 - .8 ASTM B32-08 (2014), Standard Specification for Solder Metal.
 - .9 ASTM B42-15a, Seamless Copper Tube, Standard Sizes.
 - .10 ASTM B88M-14, Standard Specification for Seamless Copper Water Tube (Metric).
 - .11 ASTM F876-15, Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
 - .12 ASTM F877-11, Standard Specification for Crosslinked Polyethylene (PEX) Hot and Cold Water Distribution System.
- .3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA)
 - .1 ANSI/AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .2 ANSI/AWWA C151/A21.51-09, Ductile Iron Pipe, Centrifugally Cast, for Water.

- .3 AWWA C904-06, Crosslinked Polyethylene (PEX) Pressure Pipe, ½ In. (12 mm) through 3 In. (76mm), for Water Service.
- .4 CSA Group
 - .1 CSA B137.5-13, Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications.
 - .2 CSA B242-05, Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S101-07, Fire Endurance Tests of Buildings Construction and Materials.
 - .2 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.
 - .3 CAN/ULC S115-11, Standard Method of Fire Tests of Firestop.
- .6 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .8 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-02a, Butterfly Valves.
 - .2 MSS-SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
- .9 National Research Council (NRC)
 - .1 National Plumbing Code of Canada (NPC) Latest Edition.
- .10 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data
 - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 Delivery, Storage And Handling

- .1 Store and manage hazardous materials in accordance with Section 02 82 10 and 02 82 11.

- .2 Packaging Waste Management: remove for reuse by manufacturer and return of crates padding, packaging materials and pallets in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Place materials defined as hazardous or toxic in designated containers.
- .4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .5 Materials and Resources Credit MRc2.1 Construction Waste Management: Divert 50% From Landfill and MRc2.2 Construction Waste Management: Divert 75% From Landfill: prepare Construction Waste Management plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 Sustainable Requirements

- .1 Construction:
 - .1 Form integral part of this project including materials and products of this Section. Sustainable construction requirements include:
 - .1 Specific construction requirements for project.
 - .2 Specification text to ensure that project will comply with PSPC green design process and sustainability requirements.
 - .3 Administrative, temporary and procedural requirements for the use of materials and methods of construction.

PART 2 PRODUCTS

2.1 Piping

- .1 Domestic hot, cold and recirculation systems, within building.
 - .1 Above ground:
 - .1 Copper tube, hard drawn, type L: to ASTM B88M.
 - .2 PEX Piping to CSA B137.5.
 - .2 Buried or embedded:
 - .1 Copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.
 - .2 PEX Piping to CSA B137.5.

2.2 Fittings

- .1 Bronze pipe flanges and flanged fittings, Class 150: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS 2 and larger:
 - .1 ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.
 - .2 PEX fittings to CSA B137.5 and F1960.
- .6 NPS 1 ½ and smaller:

- .1 Wrought copper to ANSI/ASME B16.22; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.
- .2 PEX fittings to CSA B137.5.

2.3 Joints

- .1 Rubber gaskets, 1.6mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: 95/5.
- .4 Teflon tape: for threaded joints.
- .5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM gasket.
- .6 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.
- .7 NPS 1 ½ and smaller: PEX fittings to CSA B137.5.
- .8 NPS 2 and larger: PEX fittings to CSA B137.5 and ASTM F1960. Elbows, adapters, couplings, plugs, tees, multi-port tees and valves.

2.4 Gate Valves

- .1 NPS 2 and under, soldered:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.
- .3 NPS 2 1/2 and over, in mechanical rooms, flanged:
 - .1 Rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, OS&Y bronze trim specified Section 23 05 23.02 - Valves - Cast Iron.
- .4 NPS 2 1/2 and over, [other than mechanical rooms], flanged:
 - .1 Non-rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.5 Globe Valves

- .1 NPS2 and under, soldered:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Lockshield handles: as indicated.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, screwed over bonnet, renewable composition disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Lockshield handles: as indicated.

2.6 Swing Check Valves

- .1 NPS 2 and under, soldered:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.
- .3 NPS 2 1/2 and over, flanged:
 - .1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.7 Ball Valves

- .1 NPS 2 and under, screwed:
 - .1 Class 150.
 - .2 Bronze body, [chrome plated brass] [stainless steel] ball, PTFE adjustable packing, brass gland and [Bunan] [PTFE] [TFE] seat, steel lever handle as specified Section [23 05 23.01 - Valves - Bronze].
- .2 NPS 2 and under, soldered:
 - .1 To ANSI/ASME B16.18, Class 150.
 - .2 Bronze body, chrome plated brass ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23.01 - Valves - Bronze.
- .3 NPS 2 and under, mechanical:
 - .1 To CSA B137.5 and ASTM F1960.
 - .2 Lead free brass body.

PART 3 EXECUTION

3.1 Application

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

3.2 Installation

- .1 Install in accordance with NPCC and local authority having jurisdiction.
- .2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards.
- .4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.

- .5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .6 Buried tubing:
 - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
 - .2 Bend tubing without crimping or constriction. Minimize use of fittings.
- .7 Valves
 - .1 Isolate equipment, fixtures and branches with gate or ball valves.
 - .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.3 Pressure Tests

- .1 Conform to requirements of Section 22 05 00 - Common Work Results for Plumbing.
- .2 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.4 Flushing And Cleaning

- .1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw [one] sample off longest run. Submit to testing laboratory to verify that system is clean copper to Provincial potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

3.5 Pre-Start-Up Inspections

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

3.6 Disinfection

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction approval of Departmental Representative.
- .2 Upon completion, provide laboratory test reports on water quality for Departmental Representative approval.

3.7 Start-Up

- .1 Timing: start up after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .4 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
 - .1 Establish circulation and ensure that air is eliminated.
 - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.

- .3 Bring HWS storage tank up to design temperature slowly.
- .4 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.
- .5 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

3.8 Performance Verification

- .1 Scheduling:
 - .1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.
- .2 Procedures:
 - .1 Verify that flow rate and pressure meet Design Criteria.
 - .2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
 - .4 Sterilize HWS and HWC systems for Legionella control.
 - .5 Verify performance of temperature controls.
 - .6 Verify compliance with safety and health requirements.
 - .7 Check for proper operation of water hammer arrestors. Run [one] outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
 - .8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.
- .3 Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
 - .2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.9 Operation Requirements

- .1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 05 - Installation of Pipework.
- .2 Operational requirements, include:
 - .1 Cleaning materials and schedules.
 - .2 Repair and maintenance materials and instructions.

3.10 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 Section 22.

1.2 Reference Standards

- .1 ASTM International Inc.
 - .1 ASTM D2235-04, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 - .2 ASTM D2564-04e1, Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-Series B1800-06, Thermoplastic Non-pressure Pipe Compendium - B1800 Series.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada, Latest Edition (NPC).
- .6 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of crates packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Material

- .1 Adhesives and Sealants: in accordance with Section 07 92 00 - Joint Sealants.

2.2 Piping And Fittings

- .1 For buried DWV piping to:
 - .1 CAN/CSA B181.1.
 - .2 CAN/CSA B181.2.
 - .3 CAN/CSA B182.1.
- .2 For aboveground DWV piping for combustible construction to:
 - .1 CAN/CSA B181.2
- .3 For aboveground DWV piping for non-combustible construction:
 - .1 Flame spread rating less than 25 and smoke developed classification less than 50.
 - .2 CAN/CSA B181.2

2.3 Joints

- .1 Solvent weld for PVC: to ASTM D2564.
- .2 Solvent weld for ABS: to ASTM D2235.

PART 3 EXECUTION

3.1 Application

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

3.2 Installation

- .1 In accordance with Section 23 05 05 - Installation of Pipework.
- .2 Install in accordance with local authority having jurisdiction and National Plumbing Code.

3.3 Testing

- .1 Pressure test buried systems before backfilling.
- .2 Hydraulically test to verify grades and freedom from obstructions.

3.4 Performance Verification

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.

- .3 Storm water drainage:
 - .1 Verify domes are secure.
 - .2 Ensure weirs are correctly sized and installed correctly.
 - .3 Verify provisions for movement of roof system.
- .4 Ensure fixtures are properly anchored, connected to system and effectively vented.
- .5 Affix applicable label (storm, sanitary, vent, pump discharge) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 Summary

.1 Section Includes:

- .1 The supply and installation of plumbing fixtures and trim.

1.2 References

.1 Canadian Standards Association (CSA International).

- .1 CAN/CSA-B45 Series, Plumbing Fixtures.
- .2 CAN/CSA-B125 Series, Plumbing Fittings.
- .3 CAN/CSA-B651, Barrier-Free Design.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to the Departmental Representative a complete brochure of all the new fixtures and accessories for review before placing a firm order.
- .3 Confirm styles, space, and quantities with Architectural drawings before submission.

1.4 Closeout Submittals

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

PART 2 PRODUCTS

2.1 Manufactured Units

- .1 Fixtures:
 - .1 Manufacture in accordance with CAN/CSA-B45 series.
 - .2 Confirm colour with Departmental Representative.
 - .3 Free of discoloration and flaws.
- .2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.
- .3 All exposed plumbing brass, metal supplies, traps, escutcheons, pipes, valves, fittings, etc. shall be chrome plated.
- .4 Number, types, locations: architectural drawings to govern.
- .5 Fixtures in any one location to be product of one manufacturer and of same type.
- .6 Trim in any one location to be product of one manufacturer and of same type.

- .7 Fixture piping:
 - .1 Hot and cold water supplies to each fixture:
 - .1 Chrome plated rigid supply pipes each with screwdriver stop, reducers, and escutcheon.
 - .2 Waste:
 - .1 Brass P-trap with clean out on each fixture not having integral trap.
- .8 Sealant: Colour- white, confirm with Departmental Representative.
- .9 Refer to plumbing drawings for plumbing fixture schedule and acceptable manufacturers.

2.2 Accessibility

- .1 Refer to 22 05 02 Common Work Results for Plumbing.

PART 3 EXECUTION

3.1 General

- .1 Coordinate wall and floor construction to suit fixture layout.
- .2 Provide all hangers, supports, brackets reinforcement, 1.9 mm steel backup plates, etc., for the proper installation and support of fixtures and their respective supply fittings.
- .3 All connections shall be watertight, including supplies, traps, etc.

3.2 Installation

- .1 The fixtures shall be set level and square with relation to interior finish, floor, and wall lines. Locate with equal spacing on both sides, unless specifically shown otherwise.
- .2 Mounting heights:
 - .1 Standard: to comply with the manufacturer's recommendations unless otherwise indicated or specified.
 - .2 Physically handicapped: to comply with the most stringent of either NBCC or CAN/CSA B651.
- .3 Chrome plated piping: use only strap wrenches on chrome plating piping and fittings. Replace any damaged by wrench marks. Joints to be threaded or slip union type.
- .4 Fixtures shall be piped complete in a first class manner.
- .5 Apply sealant to all joints where fixtures come in contact with floors, walls and/or counters. Joints shall be made watertight with a smooth bead of sealant applied in a neat, workmanlike manner.
- .6 After installation, fixtures shall be protected from damage, dirt and paint. Replace damaged materials. Clean only with manufacturer approved non-abrasive cleansers.

3.3 Adjusting

- .1 Adjustments:
 - .1 Adjust water flow rate to design flow rates.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
 - .3 Adjust temperature limit and safety controls.
 - .4 Adjust brass for easy, drip-free operation.
- .2 Checks:
 - .1 Aerators: operation, cleanliness.
 - .2 Strainers: cleanliness.
 - .3 Vacuum breakers, backflow preventers: operation under all conditions.
- .3 Thermostatic controls:
 - .1 Verify temperature settings, operation of control, limit and safety controls.

3.4 Demonstration

- .1 Demonstrate all special fixtures to the Owner, including operation and maintenance.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 Section 22.

1.2 Reference Standards

- .1 ASTM International
 - .1 ASTM A126-04 (2009), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .2 American Water Works Association (AWWA)
 - .1 ANSI/AWWA C700-09, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.
 - .2 ANSI/AWWA C701-12, Standard for Cold Water Meters-Turbine Type for Customer Service.
 - .3 ANSI/AWWA C702-10, Standard for Cold Water Meters-Compound Type.
- .3 CSA International
 - .1 CSA-B64 Series-11, Backflow Preventers and Vacuum Breakers.
 - .2 CSA B79-08, Commercial and Residential Drains and Cleanouts.
 - .3 CAN/CSA-B356-10, Water Pressure Reducing Valves for Domestic Water Supply Systems.
- .4 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP).
 - .1 IPMVP 2007 Version.
- .5 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada, Latest Edition (NPC).
- .6 Plumbing and Drainage Institute (PDI)
 - .1 PDI-G101-R2010, Testing and Rating Procedure for Grease Interceptors with Appendix of Installation and Maintenance.
 - .2 PDI-WH201-R2010, Water Hammer Arresters Standard.

1.3 Administrative Requirements

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning work of this Section, with Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building construction subtrades.

- .4 Review manufacturer's written installation instructions and warranty requirements.

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 [plumbing products] and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29 - Health and Safety Requirements. Indicate VOC's:
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province where work is taking place.
 - .2 Indicate on drawings to indicate accessories, dimensions, construction and assembly details, number of anchors, finishes, materials, method of anchorage.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturers' Field Reports: manufacturers' field reports specified.
- .7 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.
 - .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-industrial content, and total cost of materials for project.
 - .3 Regional Materials: submit evidence that project incorporates required percentage 10% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

1.5 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.
 - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.

1.6 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect plumbing materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, padding, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Floor Drains/Funnel Floor Drains

- .1 Floor Drains and Funnel Floor Drains: to CSA B79.
- .2 Refer to plumbing drawings for schedule and acceptable manufacturers.

2.2 Drain Pump

- .1 Refer to Plumbing Fixture Schedules.

2.3 Cleanouts

- .1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.
- .2 Access Covers:
 - .1 Wall Access: face or wall type, polished nickel bronze round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.
 - .2 Floor Access: round cast iron body and frame with adjustable secured nickel bronze top and:
 - .1 Plugs: bolted bronze with neoprene gasket.
 - .2 Cover for Unfinished Concrete Floors: cast iron round, gasket, vandal-proof screws.
 - .3 Cover for Terrazzo Finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.
 - .4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.
 - .5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

2.1 Back Flow Preventers

- .1 Preventers: to CSA-B64 Series, application as indicated.

2.2 Vacuum Breakers

- .1 Breakers: to CSA-B64 Series, vacuum breaker hose connection or atmospheric.

2.3 Pressure Regulators

- .1 Capacity: as indicated.
 - .1 Inlet pressure: 1034 kPa.
 - .2 Outlet pressure: 413 kPa.
- .2 Up to NPS 1-1/2 bronze bodies, screwed: to ASTM B62.
- .3 NPS 2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class B.
- .4 Semi-steel spring chambers with bronze trim.

2.4 Strainers

- .1 860 kPa, Y type with 20 mesh, monel, bronze or stainless steel removable screen.
- .2 NPS 2 and under, bronze body, screwed ends, with cap.
- .3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

PART 3 EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing specialties and accessories installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 Manufacturer's Instructions

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

3.3 Installation

- .1 Install in accordance with National Plumbing Code of Canada (NPC) and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

3.4 Cleanouts

- .1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.5 Back Flow Preventers

- .1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.
 - .1 Drains.
 - .2 Backwater Valves.
 - .3 Water Make-up Assembly.
 - .4 Grease Interceptors.

3.6 Strainers

- .1 Install with sufficient room to remove basket for maintenance.

3.7 Start-Up

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Timing: start-up only after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .4 Water treatment systems operational.
- .3 Provide continuous supervision during start-up.

3.8 Testing And Adjusting

- .1 General:
 - .1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.
- .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After certificate of completion has been issued by authority having jurisdiction.
- .3 Application tolerances:
 - .1 Pressure at fixtures: +/- 70 kPa.
 - .2 Flow rate at fixtures: +/- 20%.
- .4 Adjustments:
 - .1 Verify that flow rate and pressure meet design criteria.

- .2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.
- .5 Floor drains:
 - .1 Verify operation of trap seal primer.
 - .2 Prime, using trap primer. Adjust flow rate to suit site conditions.
 - .3 Check operations of flushing features.
 - .4 Check security, accessibility, removability of strainer.
 - .5 Clean out baskets.
- .6 Vacuum breakers, backflow preventers, backwater valves:
 - .1 Test tightness, accessibility for O&M of cover and of valve.
 - .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.
 - .3 Verify visibility of discharge from open ports.
- .7 Access doors:
 - .1 Verify size and location relative to items to be accessed.
- .8 Cleanouts:
 - .1 Verify covers are gas-tight, secure, yet readily removable.
- .9 Pressure regulators, PRV assemblies:
 - .1 Adjust settings to suit locations, flow rates, pressure conditions.
- .10 Strainers:
 - .1 Clean out repeatedly until clear.
 - .2 Verify accessibility of cleanout plug and basket.
 - .3 Verify that cleanout plug does not leak.

3.9 Closeout Activities

- .1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.
- .2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel, supplemented as specified.

3.10 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 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.11 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

PART 1 GENERAL

1.1 Scope

- .1 Clean all HVAC systems within the area of renovation and 10 meters beyond the area of renovation.

1.2 References

- .1 Definitions:
 - .1 HVAC System: complete air duct system from exterior penetrations/units to furthest air supply terminal unit and including:
 - .1 Rigid supply and return ductwork;
 - .2 Including all existing ductwork to 10 meters beyond the area of renovation;
 - .3 Flexible ductwork;
 - .4 Return air plenums including ceiling plenums;
 - .5 Cooling and heating coils and compartments;
 - .6 Condensate drain pans, eliminator blades and humidifiers;
 - .7 Fans, fan blades and fan housing;
 - .8 Filter housing and frames;
 - .9 Acoustically insulated duct linings;
 - .10 Diffusers, registers and terminal units;
 - .11 Dampers and controls;
 - .2 Reference Standards:
 - .1 National Air Duct Cleaners Association (NADCA)
 - .1 ACR Standard: Assessment, Cleaning and Restoration of HVAC Systems.
 - .2 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.
 - .3 United States Environmental Protection Agency (US EPA)
 - .1 US EPA, 40 CFR Parts 152 and 156.
- ### **1.3 Administrative Requirements**
- .1 Site Evaluation: conduct site visit 2 weeks before start of work to establish specific cleaning plan, determining how areas of facility and HVAC systems will be protected during cleaning operations.
 - .1 Organize and lay out plan for video survey and identify camera and cleaning apparatus insertion points.
 - .2 Ensure plan identifies sequence and schedule of survey and cleaning operations for each individual HVAC system and for complete facility.
 - .1 Take account of elbows, bends, turning vanes, dampers, transitions, take-offs, and other internal features.

- .3 Departmental Representative to review cleaning plan 1 week minimum prior to start of work.
 - .1 Proceed with cleaning work only after receiving written approval from Departmental Representative.
- .2 Scheduling:
 - .1 Conduct work during hours approved by Departmental Representative only. Allow for work after hours.
 - .2 Work may not be carried out during statutory holidays.
- .3 Project Co-ordination: assign Project Co-ordinator to oversee air duct cleaning processes.
 - .1 Provide Departmental Representative with contact information of Project Co-ordinator including: name, telephone number, cell phone number.
- .4 Security: Departmental Representative will pay costs and provide security escort at times requested on Contractor's submitted work schedule.
 - .1 Cancellation of security escort requires 72 hours minimum written notice.
 - .2 Failure to cancel security escort requirements 72 hours minimum before scheduled event will result in Contractor paying for security costs.
- .5 Damaged or broken equipment and components found during initial testing and inspection will be repaired or replaced by Departmental Representative.

1.4 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit video survey and cleaning plan developed during site evaluation.
 - .1 Ensure plan includes sequence of operation, identification of camera and cleaning apparatus insertion points and schedule for work.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.
 - .2 Provide two copies of WHMIS MSDS for antimicrobial agents or coatings.
- .4 Testing Laboratory Services: submit name and address of laboratory engaged for work of this Section.
 - .1 Submit laboratory analysis report of particulate collection indicating:
 - .1 Location of collection;
 - .2 Particulate grade;
 - .3 Particulate size;
 - .4 Percentage concentration of individual particulates in each sample.
- .5 US EPA Registration: submit verification of EPA Registration of antimicrobial agent.
- .6 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility, as described in PART 3 - CLEANING - Waste Management.

1.5 Closeout Submittals

- .1 Provide submittals in accordance with Section 01 78 00 - Closeout Submittals.

- .2 Post Cleaning Inspection Report: submit 4 copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:
 - .1 Name and address of facility;
 - .2 Name and address of HVAC cleaning contractor;
 - .3 Description of HVAC systems with drawings identifying systems cleaned;
 - .4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;
 - .5 Identification of points where samples were collected and type of analysis used for each collection;
 - .6 Identification of each sample collected;
 - .7 Comments complete with photographs of each sampling location and other observed system features;
 - .8 Identify systems tested, observations, actions taken and recommendations for future maintenance.
- .3 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility.

1.6 Extra Materials

- .1 Extra Stock Materials:
 - .1 Supply 4 extra filters for each HVAC System cleaned.
 - .2 Ensure filters are correct match, size, type and configuration of existing HVAC Systems.

1.7 Quality Assurance

- .1 Contractor: verification of 5 years minimum experience in work similar to or exceeding work of this Section.
- .2 Project Co-ordinator: verification of 5 years minimum experience in work similar to or exceeding work of this Section.

PART 2 PRODUCTS

2.1 Access Doors And Panels

- .1 Ductwork Access Doors: construct access doors from 1.27 mm minimum galvanized sheet steel with gasketted seal.
 - .1 Ensure access door is 25 mm greater in every dimension than access opening.
 - .2 Access door size 200mm x 200 mm minimum.
 - .3 Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure 3 screws per side minimum.
- .2 Access Doors and Panels Acoustic Lining:
 - .1 Install acoustic lining to match existing.
 - .2 Self-adhesive glass fibre tape capable of adhering to both acoustic lining and metal access door or panel materials.
 - .3 Water-based duct sealer for repairing cut acoustic lining.

2.2 System Filters

- .1 Supply and install new filters for each HVAC System cleaned.

2.3 Air Duct Cleaning Equipment

- .1 Manually propelled full contact brushes:
 - .1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.
 - .1 Ensure brushes are sized to fit various duct sizes in HVAC system.
 - .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.
- .2 Brushes: manually propelled with integrally-mounted motor and nylon bristles.
 - .1 Ensure motor has capacity to continue to push brush after bristles are distorted.
 - .2 Replace worn and ineffective brushes when required.

2.4 Multi-Functional Robotic Cleaning System

- .1 Self-propelled remote controlled, track or wheeled drive equipped with: camera and lights: rotating brushes, air supply nozzle, vacuum and spraying system attachment.
 - .1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.
 - .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces.
 - .3 Replace worn and ineffective brushes when required.
- .2 Camera: fully rotational remote control focus and dust proof video digital with 480 lines of resolution, capable of storing 4 hours of recorded media.
 - .1 Camera Light: 2 x 20 watt Halogen with dimmer

2.5 Hepa Filter Evacuation Fan

- .1 Evacuation Fan: includes fan, HEPA filter, flexible hose and motor capable of maintaining debris and particulates airborne in airstream until they reach evacuation fan and maintaining system under negative pressure.
 - .1 Ensure HEPA filters are clean and maintain evacuation fan and HEPA filter to run efficiently.

2.6 Hepa Vacuum Unit

- .1 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.
 - .1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

PART 3 EXECUTION

3.1 Preparation

- .1 Close down HVAC system.

- .2 Locate and identify externally visible HVAC system features which may affect cleaning process including:
 - .1 Control devices;
 - .2 Fire and smoke control dampers;
 - .3 Balancing dampers: indicate and record positions for resetting;
 - .4 Air volume control boxes: indicate and record positions for resetting;
 - .5 Fire alarm devices;
 - .6 Monitoring devices and controls;
- .3 Cut openings in ductwork for access to system interior.
 - .1 Square or rectangular opening sizes: 200 mm minimum each side.
 - .2 Circular opening sizes: 200 mm minimum diameter.
- .4 Installation of Access Doors in Ductwork: install access doors in ductwork where required to facilitate system inspection and cleaning.
 - .1 Access door installation is not permitted in flexible ductwork.
 - .1 Inspect flexible ductwork only by disconnecting from main duct and inspecting from open end.
- .5 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibre glass tape and water based duct sealer.
 - .1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.
- .6 Remove and reinstall ceiling tiles to gain access to HVAC system as required.
 - .1 Replace ceiling tiles damaged or soiled by air duct cleaning procedures.

3.2 Examination / Pre-Cleaning Inspection

- .1 Verification of Conditions:
 - .1 Make visual inspection of interior of HVAC system using remote controlled robotic camera.
 - .2 Insert camera at pre-established strategic locations to evaluate condition and cleanliness of HVAC systems and components.
- .2 Evaluation and Assessment:
 - .1 Identify location and type of internal components.
 - .2 Identify extent of potential problems.
 - .3 If toxic or hazardous materials or deposits are suspected after initial inspection immediately stop work and inform Departmental Representative.
 - .1 Do not proceed further with inspection operations until written approval from Departmental Representative.

3.3 Particulate Collection

- .1 Before starting duct cleaning, identify locations for sample collection and collect particulate samples.
- .2 Take samples from interior surfaces of HVAC system using sterile wipes for submission to independent testing laboratory.
- .3 For each HVAC system collect 4 samples from each HVAC unit as follows:

- .1 Sample 1: collect from inside ventilation unit downstream of air filters but before fan discharge;
- .2 Sample 2: collect downstream of fan discharge and 1 metre maximum downstream in first horizontal branch;
- .3 Sample 3: collect at junction of last horizontal branch and start of low-pressure duct;
- .4 Sample 4: collect at junction each air terminal unit and supply duct.

3.4 Laboratory Analysis

- .1 Ensure independent testing laboratory has demonstrated experience in work associated with air duct cleaning.
- .2 Ensure Super Electron Microscope (SEM) is used for analyzing and determining components of particulate collection samples:
 - .1 Identify components by grade and size;
 - .2 Report findings including percentage concentration of components to Departmental Representative.
- .3 Proceed with HVAC System Cleaning only after laboratory analysis test results have been received.
- .4 Ensure cleaning technicians have safety equipment appropriate for toxic or hazardous conditions identified by laboratory analysis before proceeding with cleaning operations.

3.5 Duct Cleaning

- .1 Do duct cleaning in accordance with NADCA ACR Standard.
- .2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zones which has already been cleaned.
 - .1 Isolate zone of duct using closed-cell polyurethane foam or air inflated zone bag before cleaning.
- .3 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.
- .4 Install HEPA filter evacuation fan at one end of zone section and insert full contact brushes at other end.
- .5 Clean HVAC supply air duct system and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.
- .6 Clean exhaust, return, transfer ductwork and plenums, equipment and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.
- .7 Energize brushes to travel from insertion point to HEPA filter evacuation fan.
 - .1 Pass brushes through sections as often as necessary to achieve required cleanliness.
 - .2 Change brush sizes as required to ensure positive contact with duct and component interiors.
 - .3 Clean corners and pockets where dirt and debris can accumulate.
- .8 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.

- .9 Clean diffusers, registers, louvers, and other terminal units.
- .10 Remove perforated supply diffusers from suspended tee-bar ceiling.
 - .1 Dismantle and clean perforated plates and supply diffuser duct collars.
 - .2 Re-assemble perforated plate diffusers and reconnect to HVAC system using supply diffuser duct collar after cleaning.
- .11 Advise Departmental Representative 72 hours minimum before deactivation of fire alarm and smoke detectors duct cleaning operations.

3.6 Acoustically Lined Ductwork Cleaning

- .1 Clean glass fibre acoustically insulated ducts to NAIMA recommended practices.
 - .1 Use specifically designed robotic apparatus that has been demonstrated not to damage acoustic glass fibre lining.
 - .2 Monitor cleaning process progress by onboard camera.

3.7 Components And Equipment Cleaning

- .1 Brush and vacuum coils, humidifiers, air handling unit enclosures, and heat exchanger surfaces to achieve required cleanliness.
- .2 When cleaning equipment and components by brushing and vacuuming is inappropriate or insufficient, dismantle and remove equipment or component and move to area designated by Departmental Representative for cleaning.
 - .1 Pressure wash with water and cleaning solution until required cleanliness is achieved.
 - .2 Clean equipment and components in place only if there is no hazard to adjacent materials.
- .3 Compressed air and manual cleaning is acceptable only for cleaning individual components and small areas as follows:
 - .1 Fan blades;
 - .2 Dampers;
 - .3 Turning vanes;
 - .4 Controls;
 - .5 Sensor bulbs;
 - .6 Fire alarms;
 - .7 Smoke detectors;

3.8 Anti Microbial Application

- .1 Apply antimicrobial agents when fungal growth is suspected.
- .2 Apply antimicrobial agents after removal of surface deposits and debris.
 - .1 Verify air duct interiors are free from deposits and debris by visual inspection
 - .2 Report findings to Departmental Representative.
 - .3 Proceed with application of antimicrobial agents after written approval from Departmental Representative
- .3 Apply antimicrobial agents in accordance with manufacturer's written instructions and US EPA 40 CFR registration and listing.

- .4 Manual or Robotic spray antimicrobial agents directly onto interior surfaces of HVAC air duct system.

- .1 Do not use fog mist for downstream surfaces.

3.9 Field Quality Control/Final Inspections

- .1 Post Cleaning Inspection: carry out final inspection using robotic camera and other visual inspection methods after final cleaning has been completed.

- .1 Carry out video survey as directed by Departmental Representative.

- .2 Include in final survey areas inspected by Departmental Representative prior to cleaning.

- .3 Identify on HVAC system record drawings access points used for inspection and cleaning.

- .4 Re-collect and analyze particulates collected at same locations where original samples were collected before cleaning.

- .5 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

3.10 System Startup

- .1 Install new system filters after cleaning operations are completed.

- .2 Cover each inspection opening with access door or panel and secure in place after inspection and cleaning are completed.

- .3 Restart each HVAC system.

3.11 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 Waste Management: separate waste materials for reuse and recycling.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1, Energy Standard for Buildings except Low-Rise Residential Buildings
- .2 Electrical Equipment Manufacturers' Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 No. 100, Motors and Generators
 - .2 CAN/CSA-C747, Energy Efficiency for Single- and Three-Phase Small Motors
 - .3 CAN/CSA-C390, Energy Efficiency Test Methods for Three-Phase Induction Motors
- .4 Underwriter's Laboratories of Canada (ULC)
- .5 SMACNA
 - .1 HVAC Air Duct Leakage Test Manual
 - .2 HVAC Duct Construction Standards – Metal and Flexible
- .6 Refer carefully to other parts of the specifications.
- .7 Conform to the requirements and recommendations of all local municipal, provincial and federal codes, by-laws and ordinances.
- .8 Do not reduce the quality of work specified and/or shown on the drawings because of the Regulatory requirements.

1.2 Applicable Codes And Standards

- .1 In general and as applicable, the physical and chemical properties, the characteristics and the performance of items in this Division shall be as noted in the following:
 - .1 Canadian Standards Association.
 - .2 American National Standards Institute.
 - .3 Provincial Building Code.
 - .4 Civic Building By-Laws.
 - .5 Civic Water Works By-Laws and Sewer By-Laws.
 - .6 Provincial Fire Code.
 - .7 Worker's Compensation Board Requirements.
 - .8 American Society for Testing and Materials.
 - .9 Canadian Government Specifications Board.
 - .10 National Fire Protection Association.
 - .11 Canadian Council of Ministers of the Environment Codes.
 - .12 Underwriters' Laboratories of Canada.

1.3 Latest Editions

- .1 The latest edition of all codes and standards, of the date of tender submission, shall apply; except for specific editions referenced by overriding codes.

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 specified 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 the Province where work is taking place.
 - .2 Drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Certificates:
 - .1 Provide CSA certified equipment.
 - .2 Where CSA certified equipment is not available, submit such equipment to 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 certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

1.5 Quality Assurance

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning on-site installations
 - .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.

1.6 Authorities Having Jurisdiction (Ahj)

- .1 Comply with all requirements of Authorities with competent jurisdiction, AHJ, including authorized inspectors, without additional compensation.

1.7 Permits, Fees And Certificates

- .1 In addition to the requirements in Division 01, obtain all required Certificates of Inspection for the work and deliver same to the Departmental Representative before request for substantial performance. These include but are not limited to:
 - .1 Equipment start-up reports.
 - .2 Fire, smoke, and combination fire/smoke damper test reports.
- .2 Correct installed work as directed by the local Authorized Inspector of the Regulatory body without extra compensation.

1.8 Equipment List

- .1 Compile a complete list of HVAC equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .2 Submit for review within ten (10) days after award of contract.

1.9 Specified Equipment Availability

- .1 If specified equipment is not available (due to delays in delivery) at scheduled installation time an acceptable alternate shall be installed AT THE CONTRACTOR'S EXPENSE and replaced with the specified equipment when the specified equipment becomes available with no additional compensation.

1.10 Electrical Work

- .1 Division 23 is responsible for the supply, physical installation, and operation of all electric motors, temperature and humidity controls systems, combustion controls systems, and other electrical devices and systems specified under its portion of the work. Bear full responsibility for factory installed wiring and equipment on packaged equipment, be responsible where detailed in equipment requirements for controlling devices such as, but not restricted to, pump and liquid level controls, multi-speed motor controllers, boiler controls, etc., which are necessarily integrally mounted on packaged equipment.
- .2 Submit detailed composite wiring diagrams for all control systems as specified and as required for the HVAC work for review by the Departmental Representative. Distribute copies of reviewed drawings to the Electrical Division for their reference.
- .3 Provide all wiring in approved rigid conduit to suit temperature and moisture conditions of area through which wire is to run. All wiring is in accordance with the relevant Electrical Codes, and in no case smaller than #12 AWG. Comply fully with the electrical specifications for all electrical work.

1.11 Electrical Characteristics

- .1 Check with the electrical trade and provide all mechanical items with correct electrical characteristics to suit the electrical work.
- .2 If correct characteristics are not available from the specified equipment manufacturer, contact the Departmental Representative prior to the close of tenders.

- .3 At time of ordering HVAC equipment, confirm electrical characteristics with the electrical contractor, and ensure that they have been confirmed with the power authority.
- .4 No additional compensation will be paid for problems arising from incorrect electrical characteristics.

1.12 Cutting, Patching, Repairing, Making Good

- .1 In addition to the requirements in Division 01, each trade requiring such work shall be responsible for necessary cutting. Patching by appropriate trade. All work to be performed by experienced tradesmen.
- .2 Neatly perform cutting and patching work to blend smoothly with surrounding surfaces.
- .3 Patch and make good disturbed surfaces to match existing adjacent work. Leave finished, neat, to Departmental Representative's approval.
- .4 Perform X-ray examination of wall and floors prior to making openings, where required to avoid damage to structural reinforcements and electrical conduits.

1.13 Re-Use And Relocation Of Existing Equipment

- .1 Where contract documents call for re-use or relocation of existing equipment, the contractor is to test and confirm the equipment is fully functional prior to any disconnection or work on the equipment.
- .2 Equipment found inoperable after disconnection or relocation shall be the responsibility of the contractor to repair or replace.

1.14 Tests

- .1 In addition to the requirements in Division 01, carry out all tests hereinafter noted, as required by the regulatory agencies and as requested by the Departmental Representative and furnish all labour and equipment required for such tests without extra compensation.
- .2 Before activating systems, recheck equipment, check all connections, set all controls for proper start-up, obtain necessary clearances from the electrical division, etc.
- .3 Submit to the Departmental Representative, legible report for all tests conducted, within one week of the test.
- .4 Notify the Departmental Representative at least two (2) working days ahead of all tests, so that the tests can be witnessed on a random basis.

1.15 Trial Usage

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

1.16 Functional Testing

- .1 Test all HVAC equipment, devices and systems. Test as required by the Authority having jurisdiction and Departmental Representative, submitting comprehensive reports. Example forms are available from the Departmental Representative.
- .2 Ensure all tests demonstrate compliance with the specified and manufacturers' shop drawing and catalogued performance, as well as compliance with applicable standards.

1.17 Demonstration And Operating And Maintenance Instructions

- .1 In addition to the requirements in Division 01, supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Manufacturers, or expert suppliers, to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Departmental Representative or Owner may record these demonstrations on videotape for future reference.
- .6 Submit training schedule and scope description to the Departmental Representative for review and approval for each training topic. Training shall not commence until approval of training schedule and scope if given by the Departmental Representative.

1.18 Spare Parts

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals and as follows:
 - .1 One set of filter media/cartridges, for each filter or filter bank in addition to final operating set.

1.19 Special Tools

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

1.20 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 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 Maintenance data to include:

- .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
- .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. [Include changes to existing mechanical systems, control systems and low voltage control wiring].
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.21 Maintenance Material Submittals

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

1.22 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

1.23 Substantial Completion / Certification By Engineer / Life Safety Submissions

- .1 Provide minimum notice of ten (10) working days to the Departmental Representative prior to request to declare project substantially complete. Failure to do so may result in site review by Engineer being delayed.
- .2 In addition to the requirements of Division 01 submit the following (as applicable) a minimum of five (5) working days ahead of required proposed date of substantial completion (unless a longer period of time is dictated by Authorities Having Jurisdiction):
 - .1 All certificates and documentation required by Authorities Having Jurisdiction.
 - .2 Fire and smoke damper test reports.
 - .3 Smoke exhaust/management systems commissioning reports
 - .4 Equipment start-up reports.
 - .5 Control systems commissioning reports pertaining to equipment/systems required for life safety system operation (i.e. ventilation interlocks/unit operation, CO detection/exhaust systems, etc.).
 - .6 Test reports for backflow prevention devices with test taps.
 - .7 Written confirmation that propane system is approved by the utility and/or Authority Having Jurisdiction, and turned on.
 - .8 Record ('As-Built') drawings.
 - .9 Operation and Maintenance Manuals, complete with revisions as directed.
 - .10 Written confirmation that all life safety and health systems are fully functional, including but not limited to ventilation, both supply and exhaust.
 - .11 Written confirmation that all HVAC equipment is operational and under control, indicating exceptions and temporary controls/arrangements.
 - .12 All other life safety and health reports and certificates.

- .3 Confirm, in writing, systems are ready for occupancy and use for intended purpose in every respect.
- .4 Before certification date submit detailed written confirmation of completion of deficient life safety work noted in the documentation listed above, including date completed.
- .5 Before certification date submit detailed written confirmation of completion of deficient non-life safety work, including that noted in Departmental Representative reports, listing each deficient item. Submit schedule for completion of all deficient non-life safety work that will not be completed prior to the certification date, listing each deficient item for consideration.
- .6 These requirements apply to each phase of a phased project.

1.24 Fan Connections

- .1 Inlet and discharge conditions are critical to proper fan performance. Review proposed fan installations and ensure that proper conditions are provided; add straightening vanes or turning vanes where required.
- .2 In general, provide a minimum of three (3) wheel diameters of straight duct immediately upstream of the fan inlet.
- .3 Review special cases with the Departmental Representative and TAB Contractor prior to installation.

PART 2 PRODUCTS

2.1 Motors

- .1 Motors to be high efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1.
- .2 Comply with all Canadian Electrical Code requirements, and in particular CSA C22.2 No. 100, c/w CSA label, unless otherwise specified.
- .3 Motors included in the scope of CAN/CSA-C747 shall have a nominal full-load efficiency not less than the minimum specified in that standard. Efficiency ratings of motors included in the scope of this standard shall be based on a statistically valid quality control procedure conforming to the standard. Nameplates shall list the nominal full-load motor efficiency.
- .4 Motors included in the scope of CAN/CSA-C390 shall have a nominal full-load efficiency not less than the minimum specified in that standard. Efficiency ratings of motors included in the scope of this standard shall be based on a statistically valid quality control procedure conforming to the standard. Nameplates shall list the nominal full-load motor efficiency.
- .5 In general, motors are EEMAC Class B (for standard torque applications), 1,800 RPM, continuous duty, open drip proof, ball bearing, 40°C temperature rise above 40°C ambient, 1.15 service factor. Motors are squirrel cage induction unless specifically noted otherwise. Special motors are specified with the equipment driven.
- .6 Single-phase motors shall be equipped with integral thermal overload protection.
- .7 Provide adequate capacity on each motor to operate the associated driven device under all conditions of load and service without overloading and be of at least the power specified.

- .8 Refer to Division 26 and provide motor characteristics within +5% of power source, or get written approval from the Departmental Representative.
- .9 Co-operate with Division 26 during start-up and provide all necessary assistance in commissioning.
- .10 Acceptable motor manufacturers may be listed under the Section 23 05 03 – Acceptable HVAC Manufacturers/Contractors.
- .11 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

2.2 Coupling For Direct Drive Equipment

- .1 Couplings shall be sized such that it will endure an infinite number of starts when equipment is fully loaded. All couplings shall be covered with a removable safety guard.

2.3 Belt Drives

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave to be determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed.

2.4 Guards

- .1 Provide guards for all drives as specified and required by Authorities Having Jurisdiction.
- .2 Guards for belt drives (minimum requirements):
 - .1 Expanded galvanized metal screen welded to galvanized steel frame.
 - .2 Minimum 1.2 mm thick galvanized sheet metal tops and bottoms.
 - .3 Prime coat for painting.
 - .4 38 mm diameter holes on both shaft centres for insertion of tachometer.
 - .5 Allow movement of motors for adjusting belt tension.
- .3 Guards for flexible couplings (minimum requirements):
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Prime coat for painting.
- .4 Guards are to be readily removable to permit servicing of equipment.
- .5 Provide means to permit lubrication and use of test instruments with guards in place.

- .6 Ensure that all guards are securely fastened in place, sufficiently sturdy to provide the required safety and free of rattles and excess vibration.

2.5 Fire Separation Repair

- .1 Refer to Section 07 84 00 – Firestopping.
- .2 Cooperate fully with other trades to ensure maintenance of the rating of fire separations that are penetrated, in strict compliance with the manufacturer's recommendations and requirements of the Authority having jurisdiction.

2.6 Accessibility

- .1 Refer to Section 10 90 00 – Miscellaneous Specialties for access door specification.
 - .1 Standard Type:
 - .1 Door and Trim: 14 gauge steel. Trim 1-1/2 inches wide.
 - .2 Return Frame: 18 gauge steel. Depth 1-3/4 inches.
 - .3 Hinges: Fully-concealed. Opens 170 degrees. On long side of door. Number of hinges
 - .4 varies with size of door.
 - .5 Latches: Flush, stainless steel cam-operated with screwdriver. Positioned opposite hinge
 - .6 and at top and bottom on larger sizes.
 - .7 Finish: Electrostatically-applied, baked grey enamel coat over rust-inhibiting phosphate
 - .8 Treated steel.
 - .9 Masonry Anchor Straps: Minimum of 4 straps per door, where required
 - .10 Cylinder Lock: Keyed alike with 2 keys per lock.
 - .11 Gaskets: Weather-resistant and air-tight neoprene gaskets.
 - .2 Fire Rated Type:
 - .1 UL Listed: rating to match assembly being installed in, 250 degrees C (450 degrees F) maximum temperature rise in 30 minutes for vertical wall installations.
 - .2 Frame: 16 gauge steel, 2 1/2 inches deep.
 - .3 Insulation: 2 inches thick mineral wool in between 2 pieces of 22 gauge steel.
 - .4 Hinge: Continuous piano hinge allows opening to 180 degrees. Hinge is on long side of door.
 - .5 Latches: Specially designed Ultra Lock-self-latching keyed cylinder paddle latch opposite hinge.
 - .6 Automatic panel closer on all doors. Vertical position only. Ceiling position has self-assisted closing.
 - .7 Inside panel release on all doors.
 - .8 Rust-inhibiting phosphate treated steel. This coating can be used as a finish or as a prime coat.
 - .9 Finish: Electrostatically-applied, baked grey enamel coat over rust-inhibiting phosphate treated steel.
 - .10 Hot smoke seal gasketing for 4 sides.

- .2 Be responsible for supplying and locating all access panels in the ceiling, wall, partitions, etc., where openings are necessary for the inspection, servicing and/or removal of equipment, valves and other items that require periodic access. Panel type to suit the construction of the ceilings, walls, partitions, etc., in which they are located. Determine the location subject to the approval of the Departmental Representative. Access panels to be installed by trade experienced in work with surface in which the panel is to be installed.
- .3 Mark mechanical access points in accessible ceilings with distinctive but inconspicuous tags properly attached to the ceiling grid. Obtain sample approval before purchase and installation. Indicate on record drawings.
- .4 Accessibility shall be defined as:
 - .1 Ability to place both hands on equipment or device, with no duct, pipe or other equipment in the way.
 - .2 Must be accessible while standing on maximum 2400 mm high stepladder.
 - .3 Must be in plain view.
- .5 Mark mechanical access points in accessible ceilings with distinctive but inconspicuous tags properly attached to the ceiling grid. Obtain sample approval before purchase and installation. Indicate on record drawings.

2.7 Sleeves And Penetrations

- .1 Install sleeves for all piping passing through floors and walls.
- .2 Sleeves as specifically noted, or through structural walls shall be Schedule 40 steel. All other sleeves are 6 mm galvanized sheet steel.
- .3 Fit sleeves flush on either side of the wall through which they pass, extend sleeves through floors and terminate 50 mm above finished floor. Adjust as necessary to accommodate the requirements of through-penetration fire-stopping systems.
- .4 Where passing through walls, make sleeves a minimum 6 mm clear of the piping, through floors make sleeves a minimum of 20 mm clear of the piping. Pack for full depth with fiberglass insulation & finish with a lagging compound. Penetrations through fire separations shall be repaired to maintain rating.
- .5 Provide escutcheon plates with setscrews to completely cover openings for all exposed pipes passing through walls, subject to the approval of the Departmental Representative. Provide chrome-plated plates in finished areas unless otherwise approved.
- .6 Be responsible for maintaining integrity of building envelope when making penetration to install equipment or devices. Enlist services of qualified trade to make openings in and/or repairs to building envelope.
- .7 Sleeving through steel beams shall be permitted only where approved by the Departmental Representative in writing or where expressly indicated on the Contract Documents. Sleeves are NOT permitted in concrete beams.
- .8 Seal all sleeves to make watertight.

2.8 Counter Flashings

- .1 In addition to the requirements in Division 01, provide watertight, non-corroding, counter flashings for all penetrations of the building envelope, painted to match adjacent materials after proper preparation and painting. Refer to drawings, including building drawings, for additional information.

- .2 Installation to allow for movement and accommodate high temperatures where necessary.
- .3 For short pipes, the flashing may overlap the end, in lieu of attachment to the pipe. Minimum 300 mm high above the roof, c/w water break above maximum water level on the roof, to negate wind effects.
- .4 All galvanized material to be 0.7 mm thick minimum.
- .5 In exposed locations, flashings must be aesthetically acceptable to the Departmental Representative.
- .6 Co-ordinate with all other trades including roofer and metal wall panel installer.
- .7 For copper pipe use 0.82 mm sheet copper, soldered to pipe end c/w solder joints.
- .8 For galvanized ducts use galvanized sheet metal soldered to the duct and c/w soldered joints.
- .9 For cast iron and steel pipes at normal temperature, use manufactured stretch fit heavy neoprene flashings c/w galvanized protective layer.
- .10 For hot pipes clamp galvanized to the pipe with a temperature rated gasket and stainless steel worm gear clamp.
- .11 For aluminum and stainless steel, use the same materials for the flashing.
- .12 For manufactured hoods, fans and rooftop unit mounting, apply a low density neoprene gasket all around and fasten securely.

PART 3 EXECUTION

3.1 General

- .1 All Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Do not scale the Drawings. Consult the Architectural Drawings and details for exact locations of fixtures and equipment; where some are not definitely located, obtain this information from the Departmental Representative.
- .2 Follow Drawings as closely as possible in laying out work and check Drawings of all other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. When headroom or space conditions appear inadequate, notify the Departmental Representative before proceeding with the installation.
- .3 Make reasonable modifications in the layout as needed without extra compensation to prevent conflicts with work of other trades or for proper execution of the work. This shall include, but not necessarily be confined to, offsets in piping or ducts, transformation in ductwork and relocation of ducts and piping up to 3.0 m either way on each item as required to suit on site job conditions.
- .4 Where variances occur between the Drawings and Specifications or within either document itself, include in the contract, the item or arrangement of better quality, greater quantity, and higher cost or clarify before tenders close. The final decision on the item and manner in which work is installed rests with the Departmental Representative.
- .5 Provide, with all trades involved, marked-up drawings, when requested, of mechanical spaces indicating all dimensions for all installations prior to the work being done. Report any discrepancies to the Departmental Representative. Any conflicts arising that may have been resolved by laying the work out in this manner will be resolved WITHOUT ADDITIONAL COMPENSATION.

- .6 Provide 48 hours minimum notice to Departmental Representative and Owner of all work before it is concealed. Expose concealed work for inspection, upon request, when proper notice was not provided and pay all costs therefore, including making good other trades' work.

3.2 Surveys And Measurements

- .1 Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements shown on the Drawings at the site, and check the correctness of same as related to the work.
- .2 Notify the Departmental Representative if any discrepancy is discovered between the actual measurements and those indicated which prevent following good practice or the intent of the Drawings & Specifications. Do not proceed with the work until receiving instructions from the Departmental Representative.

3.3 Co-Ordination

- .1 Give full co-operation to those doing work under other Divisions of the specifications and furnish in writing with copies to the Departmental Representative any information necessary to permit the work of all Divisions to be installed satisfactorily and with least possible interference or delay.
- .2 Discuss work with other Divisions prior to installation. Confirm proposed locations for equipment installed by this Division will not interfere with work installed by others.
- .3 If work is installed before coordinating with other trades or so as to interfere with work of other trades, make necessary changes in the work to correct the conditions without extra compensation.
- .4 When requested, provide marked up drawings indicating required clearances for installation of plumbing equipment. Provide section drawings indicating location of other equipment not installed by Division 23, such as other equipment and piping, cable trays, etc. Report any discrepancies to the Departmental Representative.

3.4 Accessibility

- .1 Locate all equipment that must be serviced, operated or maintained in fully accessible positions, with minimum interference and maximum usable space. If required for better accessibility, furnish access doors for this purpose. Make deviations from Drawings to allow for good accessibility, obtaining prior approval for changes of magnitude.

3.5 Scaffolding, Rigging, Hoisting

- .1 Unless otherwise specified, furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment apparatus furnished. Remove same from the premises when no longer required.
- .2 Take precautions not to overload the structure in any manner nor provide inadequate scaffolding and rigging so as to endanger the safety of personnel on the site whether under this Division's employ or otherwise.

3.6 Cutting And Patching

- .1 Cutting shall be performed neatly by this trade. No hammering or other methods are permitted without approval of the Departmental Representative and other trades affected. Utilize a rebar detector and stud finder to ensure cutting does not damage other elements.

- .2 Patching is to be done by the appropriate trade. Arrange and pay for all patching not specifically specified elsewhere in these specifications, including fire rated patching at fire separations.
- .3 Fill voids around pipes and ducts with fiberglass batt insulation and sheet metal closure strips. For fire separations, install fire stop material in accordance with manufacturer's details as required to meet the UL classification and to match separation rating. Ventilate adequately during curing. Provide adequate structural support in larger spaces. Install slightly above floors to provide positive drainage away from pipe or duct.
- .4 Provide a structural shop drawing stamped by a Professional Engineer showing all reinforcements required for openings through the structure. Allow for all costs of the reinforcement.

3.7 Supports

- .1 Provide all necessary and recommended supports for all equipment furnished under this Division. Co-ordinate and facilitate all necessary and recommended foundations, pads, bases and piers provided under other Divisions for equipment furnished or installed under this Division.

3.8 Waterproofing

- .1 Obtain approval for the installation method employed where any work pierces waterproofing concrete and waterproofing. Furnish all necessary grout rings sleeves, caulking, curbs, counter flashing and flashing required to make openings through roofs, walls, floors, etc., absolutely watertight. This applies to, but is not restricted to, roof exhausters, relief vents, penthouses, ducts, grilles, pipes, etc. Work involving the roofing is done in conjunction with the roofing Division. Work passing through roofing is to be done in accordance with applicable C.R.C.A. "FL" Series details.

3.9 Protection

- .1 Protect the work and material of all other sections from damage and make good all damage thus caused, to the satisfaction of the Departmental Representative.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

3.10 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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.11 Painting Repairs And Restoration

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.12 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.
 - .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.

3.13 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.14 Protection

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

3.15 Equipment Start-Up

- .1 HVAC contractor shall ensure that all electrical/HVAC components match and that it is safe to start-up HVAC equipment.
- .2 All support such as electrical contractor, controls contractor, etc., shall be arranged by the mechanical and all trades directly involved in equipment being started shall be present for start-up.

3.16 Manufacturers' Recommendations

- .1 Install, adjust, test, start-up, and maintain all equipment in strict accordance with the manufacturer's recommendations. If in conflict with the drawings and specifications, contact the Departmental Representative for clarification.
- .2 Ensure that the manufacturer recommends the product for its intended use. If in doubt, contact the Departmental Representative.

3.17 Personnel Protection

- .1 In addition to the requirements in Division 01, provide visual warning signs and/or markers and mechanical protection devices for all mechanical items mounted below the minimum limits listed below and suspended more than 1500mm clear of the floor.
 - .1 Occupied spaces 2286 mm (7'-6").
 - .2 Service spaces 2133 mm (7'-0").
 - .3 Crawl spaces 1524 mm (5'-0").

- .2 Visual warning devices to be yellow tape with black stripes adhered to the entire perimeter of the item infringing on the occupied space. This will include but not be limited to:
 - .1 Length of pipes or equipment below specified height.
- .3 Mechanical protection devices to be 7 mm (1/4") wire mesh guard and/or 25 mm thick 'Armaflex' type insulation. This will include but not be limited to:
 - .1 Pipe and equipment hangers.
 - .2 Valves.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B139, Installation Code for Oil Burning Equipment.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4 National Fire Code of Canada (NFCC 2005)
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113, Architectural Coatings.
 - .2 SCAQMD Rule 1168, Adhesive and Sealant Applications.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures. Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Material

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

- .3 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

PART 3 EXECUTION

3.1 Application

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

3.2 Connections To Equipment

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 Clearances

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 Drains

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 Air Vents

- .1 Install automatic air vents at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 Dielectric Couplings

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.7 Pipework Installation

- .1 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Install ball valves for glycol service.
 - .9 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 Sleeves

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 Escutcheons

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one-piece type with set screws.
 - .1 Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: outside diameter to cover opening or sleeve.
 - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 Preparation For Fire Stopping

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 Flushing Out Of Piping Systems

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 Pressure Testing Of Equipment And Pipework

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 Existing Systems

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Allow for providing provisions for isolating existing building system for new systems to permit installation of new system and also to permit continual operation of the existing system and remainder of building during constructions.
 - .1 This work may involve installation of new valves, re-routing and reconfiguration of piping, special services such as piping freeze stopping or isolation.

3.14 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

Part 2 Products

2.1 SLIP TYPE EXPANSION JOINTS

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150, 1MPa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 minimum, PTFE impregnated non-asbestos.
- .9 Thermal plastic packing: PTFE impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
 - .1 Plunger body: heavy wall carbon steel welded to body.
 - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

2.2 BELLOWS TYPE EXPANSION JOINTS

- .1 For axial, lateral or angular movements, as indicated.
- .2 Maximum operating pressure: 1034 kpa
- .3 Maximum operating temperature: 200 degrees C.
- .4 Type A: controlled flexing, factory tested to 1 times maximum working pressure. Provide test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 times maximum working pressure. Provide test certificates.
- .6 Bellows:
 - .1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

- .7 Reinforcing or control rings:
 - .1 2 piece nickel iron.
- .8 Ends:
 - .1 flanges to match pipe.
- .9 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
 - .1 Carbon steel, painted.

2.3 GROOVED END EXPANSION JOINTS

- .1 Packless, Gasketed, Slip, Expansion Joints:
 - .1 2413 kPa maximum working pressure.
 - .2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.
 - .3 PTFE modified polyphenylene sulfide coated slide section.
 - .4 Suitable for axial end movement to 75 mm.
- .2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

2.4 FLEXIBLE CONNECTION

- .1 Application: to suit motion.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offsets.
- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: to match piping with flanged ends.
- .6 Operating conditions:
 - .1 To match system requirements.
- .7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.5 ANCHORS AND GUIDES

- .1 Anchors:
 - .1 Provide as indicated.
- .2 Alignment guides:
 - .1 Provide as indicated.
 - .2 To accommodate specified thickness of insulation.

- .3 Vapour barriers, jackets to remain uninterrupted.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install expansion joints with cold setting, as instructed by Departmental Representative. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

3.3 PIPE CLEANING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.4 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification: Mechanical Piping Systems.

3.5 CLEANING

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

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition 1971.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 Action And Informational Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Submittals to include:
 - .1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.
 - .2 Service conditions.
 - .3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.
 - .4 Accuracy statements for each component at specified flow rates and other conditions.
 - .5 Flow and temperature ranges.
 - .6 Signal processor calibration data.
 - .7 Minimum turndown ratio.
- .3 Samples:
 - .1 Submit sample in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .5 Closeout Submittals:
 - .1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Accuracy

- .1 Calculate overall accuracy of each installation using following expression: Overall accuracy = $(E (\text{accuracy of individual components of system})^2)^{1/2}$.
- .2 Components to include:
 - .1 Primary flow measuring elements.
 - .2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
 - .3 RTD's.
 - .4 Signal processors, recorders.
 - .5 Calibration of signal processors: assume 0.20% per processor.
 - .6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.
- .3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.
- .4 Indicate minimum measurable flow rate.

2.2 Direct Reading Thermometers

- .1 Thermometer characteristics:
 - .1 To CAN/CGSB14.4.
 - .2 Type - Industrial, variable angle, liquid filled.
 - .3 Case - die cast aluminum with glass front.
 - .4 Scale - 225 mm long V-shaped aluminum.
 - .5 Face - non-reflective enamel white with black numerals.
 - .6 Fill - blue liquid.
 - .7 Accuracy - to 1% of full scale range.
 - .8 Scale range - to suit particular application.
 - .9 Dual scale: Celsius and Fahrenheit

2.3 Thermometer Wells

- .1 Copper pipe: copper or bronze.

- .2 Steel pipe: brass.

2.4 Pressure Gauges

- .1 Gauge characteristics:
 - .1 To ASME B40.100.
 - .2 Case - stainless steel with solid front and gasketted pressure relief back.
 - .3 Dial size - 112 mm diameter.
 - .4 Face - enamel white with black numerals.
 - .5 Pointer - black finished brass, adjustable micrometer type.
 - .6 Grade 2A, phosphor bronze Bourden tube constructed silver soldered to socket and tip.
 - .7 Movement - stainless steel rotary type with nickel silver shaft and pinion gear.
 - .8 Glycerin filled.
 - .9 Accuracy - to 0.5% of full scale range.
 - .10 Scale range - to suit particular application.
 - .11 Dual scale: psi and kPa.
- .2 Provide:
 - .1 Siphon for steam service.
 - .2 Snubber for pulsating operation.
 - .3 Isolation valve, ball type.

2.5 Auxiliary Test Ports

- .1 Instrument test ports for reading of temperature and pressure via insertion probe. NPT ¼ brass body with cap, self-sealing neoprene valve core. Length and construction to suit application.

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 Preparation

- .1 Before final calculations for orifice diameter, and before purchase of equipment measure:
 - .1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
 - .2 For concentricity of pipe.

3.3 Installation Of Primary Element

- .1 Follow manufacturer's instructions.

3.4 Installation Of Differential Pressure Taps And Piping

- .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.

- .2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

3.5 Installation Of Transmitters Not Forming Integral Part Of Primary Element

- .1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

3.6 Installation Of Signal Transmission Cable

- .1 Ground shielding at one point only.
- .2 Protect against RF interference.
- .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

3.7 Start-Up

- .1 Follow manufacturer's recommendations.

3.8 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
- .3 Shop Drawings:
 - .1 Submit data for valves specified in this Section.

1.3 Closeout Submittals:

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

1.4 Maintenance Material Submittals

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.

- .4 Valve handles: 2 of each size.
- .5 Gaskets for flanges: one for every 10 flanged joints.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Materials

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends or grooved ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 3 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.

- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: lockshield.
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, union bonnet.
 - .2 Operator: handwheel.
- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: lockshield.
 - .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: lockshield.
 - .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: handwheel.
 - .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.

- .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: handwheel.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number [6] composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.
- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders.

- .4 Stem: tamperproof ball drive.
- .5 Stem packing nut: external to body.
- .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
- .7 Stem seal: TFE with external packing nut.
- .8 Operator: removable lever handle.
- .9 Butterfly Valves:
 - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: lever.

PART 3 EXECUTION

3.1 Installation

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.2 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping.
- .2 ASTM International
 - .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 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals

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

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 System Description

- .1 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. Amount of adjustment in accordance with MSS SP58.

2.2 General

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.
- .2 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .3 Upper attachment structural: Suspension from lower flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9mm.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL/ULC listed to MSS-SP69.
- .4 Upper attachment structural: Suspension from upper flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, ULC listed to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut ULC listed.
- .5 Upper attachment to concrete.
 - .1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed to MSS SP69.
- .6 Shop and field-fabricated assemblies.
 - .1 Trapeze hanger assemblies: steel, sized to suit load.
 - .2 Steel brackets: sized to suit load.

- .7 Hanger rods: threaded rod material to MSS SP58.
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Size based on the following schedule:
 - .1 10 mm rod for pipes up to 50 mm diameter.
 - .2 12 mm rod for 65 mm and 75 mm diameter.
 - .3 16 mm rod for 100 mm diameter.
 - .4 20 mm rod for 150 mm diameter.
 - .5 22 mm rod for 200 mm to 300 mm diameter.
- .8 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 hot pipework.
 - .4 Oversize pipe hangers and supports.
- .9 Adjustable clevis: material to MSS SP69, ULC listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .10 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .11 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.
- .12 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.
- .13 For refrigerant piping use a manufactured support system consisting of:
 - .1 U-shaped channel of gauge and size as recommended by manufacturer to support the load.
 - .2 Thermoplastic elastomer cushion that surrounds piping and hinges open for easy insertion of piping.
 - .3 Clamp with electro chromate finish that secures cushion to channel by means of shaped end tabs that fit into the U-shaped channel and a tightening bolt at the top.

2.3 Wall Support

- .1 For piping supported off wall, roof or floor, use a manufactured support system consisting of:
 - .1 U-shaped channel of gauge and size as recommended by manufacturer to support the load.
 - .2 Thermoplastic elastomer cushion that surrounds piping and hinges open for easy insertion of piping.
 - .3 Clamp with electro chromate finish that secures cushion to channel by means of shaped end tabs that fit into the U-shaped channel and a tightening bolt at the top.
- .2 Spacing shall be as recommended by manufacturer for load being supported.

- .3 For groups of piping that are arranged perpendicular to wall, install Unistrut to form a triangular angle bracket.

2.4 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, ULC listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 Insulation Protection Shields

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 Constant Support Spring Hangers

- .1 Springs: alloy steel to ASTM A125, shot-peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 Variable Support Spring Hangers

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger to be 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.

2.8 Equipment Supports

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Division 05 - Structural Steel for Buildings.

- .2 Submit calculations with shop drawings.

2.9 Equipment Anchor Bolts And Templates

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

2.10 House-Keeping Pads

- .1 For base-mounted equipment: Concrete, at least 100 mm high, 50 mm larger all around than equipment, and with chamfered edges.

2.11 Roof Mounted Equipment And Services

- .1 Applies to exterior piping and conduit on roof, condensing units.
 - .1 Does not apply to ERV. ERV shall have factory curb.
- .2 Manufactured support system for support of gas and refrigeration piping systems, cable tray, electrical conduit, multiple lines, HVAC equipment.
 - .1 Material
 - .1 Base - 100% recycled rubber, UV resistant
 - .2 Channel - 14 gauge galvanized steel (1 5/8" wide x 1 5/8" high)
 - .2 Maximum Load - 750 lbs. - for each 9.6" long support

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

- .6 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.
- .7 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.

3.3 Hanger Spacing

- .1 Plumbing piping: to National Plumbing Code of Canada and t Provincial Code.
- .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 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within [300] mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .7 Pipework greater than NPS 12: to MSS SP69.

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.

3.5 Horizontal 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 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 Final Adjustment

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 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 Waste Management: separate waste materials for reuse and recycling.
 - .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 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
 - .2 Sustainable requirements for construction and verification.

1.2 References

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.3 Action And Informational Submittals

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 Quality Assurance

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Manufacturer's Equipment Nameplates

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

- .2 Use maximum of 25 letters/numbers per line.
- .4 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: size #9.
 - .2 Source and Destination identifiers: size #6.

- .3 Terminal cabinets, control panels: size #5.
- .3 Equipment elsewhere: sizes as appropriate.

2.3 Existing Identification Systems

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 Piping Systems Governed By Codes

- .1 Identification:
 - .1 Sprinklers: to NFPA 13.
 - .2 Standpipe and hose systems: to NFPA 14.

2.5 Identification Of Piping Systems

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
--------------------	-----------------

Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID

2.6 Identification Ductwork Systems

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.7 Valves, Controllers

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.8 Controls Components Identification

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Timing

- .1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 Installation

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

- .2 Provide ULC, CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

3.4 Nameplates

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
 - .1 Do not paint, insulate or cover.

3.5 Location Of Identification On Piping And Ductwork Systems

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which 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, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 Valves, Controllers

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .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.

3.7 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 Waste Management: separate waste materials for reuse and recycling.
 - .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 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 Qualifications Of TAB Personnel

- .1 Submit names of personnel to perform TAB to Departmental Representative within 30 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 Purpose Of TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 Exceptions

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 Co-Ordination

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 Pre-TAB Review

- .1 Review contract documents before project construction is started confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 Start-Up

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 Operation Of Systems During Tab

- .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.9 Start Of TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weather stripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.

- .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
- .4 Correct fan rotation.
- .5 Fire, smoke, volume control dampers installed and open.
- .6 Coil fins combed, clean.
- .7 Access doors, installed, closed.
- .8 Outlets installed, volume control dampers open.
- .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 Application Tolerances

- .1 Do TAB to following tolerances of design values:
 - .1 Other HVAC systems: plus 5 %, minus 5 %.
 - .2 Hydronic systems: plus or minus 10 %.

1.11 Accuracy Tolerances

- .1 Measured values accurate to within plus or minus 2 % of actual values.

1.12 Instruments

- .1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 Action And Informational Submittals

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 Preliminary TAB Report

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.15 TAB Report

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 Verification

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 Settings

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, and ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 Completion Of TAB

- .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.19 Air Systems

- .1 Standard: TAB to most stringent of this section.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 and as follows:
 - .1 Hydronic heating systems, including all terminal units
 - .2 Ventilation system including all inlets and outlets, terminal units, ducted fan coils, and ERV
 - .3 Test and tag all fire dampers
- .3 Qualifications: personnel performing TAB current member in good standing of AABC and NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by AABC and NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:

- .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
- .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 Other TAB Requirements

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.

1.21 Post-Occupancy TAB

- .1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used.

PART 3 EXECUTION

3.1 Not Used

- .1 Not used.

END OF SECTION

PART 1 GENERAL

1.1 Summary

.1 Section Includes:

- .1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 References

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 Action And Informational Submittals

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing.
 - .2 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.
 - .6 Manufacturer's field reports specified.

PART 2 PRODUCTS

2.1 Test Instruments

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.

- .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
- .3 Flow measuring instrument compatible with the orifice plate.
- .4 Calibration curves for orifice plates used.
- .5 Flexible duct for connecting to ductwork under test.
- .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .5 Re-calibrated every six months thereafter.

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 Test Procedures

- .1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
 - .1 Fittings, branch ducts, tap-ins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 Site Tolerances

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Small duct systems up to 250 Pa: leakage 2%.
 - .2 VAV box and duct on downstream side of VAV box: leakage 2%.
 - .3 Large low pressure duct systems up to 500 Pa: leakage 2%.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 Testing

- .1 Test ducts before installation of insulation or other forms of concealment.

- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.
- .4 Flexible connections to VAV boxes.

3.5 Cleaning

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 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 ASTM International Inc.
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .9 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36, Commercial Adhesives.
 - .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168, Adhesive and Sealant Applications.

- .6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .7 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.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.
- .3 Samples:
 - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .2 Mount sample on 12 mm plywood board.
 - .3 Affix typewritten label beneath sample indicating service.
- .4 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, cleaning procedures.

1.3 Quality Assurance

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards, member of TIAC.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.

- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Fire And Smoke Rating

- .1 To CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 Insulation

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 Jackets

- .1 Canvas:
 - .1 220 gm/m2 fire resistant cotton, plain weave, to ASTM C921 and ULC listed.
 - .2 Lagging adhesive: inorganic, water-based fire-resistive lagging adhesive and coating, ULC listed.

- .2 Aluminium:
 - .1 Jacket: To ASTM B209, minimum H-14 temper with heat-laminated moisture barrier liner.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Stucco embossed.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.4 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 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m2.
- .5 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.
- .6 Contact adhesive: quick-setting
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .10 Fasteners: 14 gauge diameter pins with 30mm diameter or 927 mm2 square clips, pin length to suit thickness of insulation.

PART 3 EXECUTION

3.1 Application

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

3.2 Pre-Installation Requirements

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 Installation

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 Ductwork Insulation Schedule

- .1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing plenum	C-1	yes	25
Mixing plenums	C-1	[yes]	25
Exhaust duct between dampers and louvers	C-1	[no]	25
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts	C-1		

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

- .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

- .1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to	CRF/3	CRD/4

precipitation		
Outdoor, elsewhere	CRF/4	CRD/5

3.5 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .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 Section Includes:
 - .1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-[03], Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-[01], Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-[1997], Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-[03], Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 Definitions

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.4 Action And Informational Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5 Quality Assurance

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, member of TIAC.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Fire And Smoke Rating

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: to ASTM C533.

- .2 Design to permit periodic removal and re-installation.

2.3 Insulation Securement

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum..
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or Air drying on mineral wool, to ASTM C449/C449M.

2.5 Vapour Retarder Lap Adhesive

- .1 Water based, fire retardant type, compatible with insulation.

2.6 Indoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 Outdoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m2.

2.8 Jackets

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: white unless otherwise specified.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .7 Special requirements:
 - .1 Outdoor: UV rated material at least 0.5 mm thick.
- .2 ABS Plastic:
 - .1 One-piece moulded type and sheet with pre-formed shapes as required.
 - .2 Colours: white unless otherwise specified
 - .3 Minimum service temperatures: -40 degrees C.
 - .4 Maximum service temperature: 82 degrees C.

- .5 Moisture vapour transmission: 0.012 perm.
- .6 Thickness: 0.75 mm.
- .7 Fastenings:
 - .1 Solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .8 Locations:
 - .1 For outdoor use ONLY.
- .3 Canvas:
 - .1 220 and 120 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .4 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
- .5 Stainless steel:
 - .1 Type: 304.
 - .2 Thickness: 0.25 mm.
 - .3 Finish: stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.9 Weatherproof Caulking For Jackets Installed Outdoors

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Pre-Installation Requirement

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 Installation

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 Removable, Pre-Fabricated, Insulation And Enclosures

- .1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: high temperature fabric.

3.5 Installation Of Elastomeric Insulation

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.6 Piping Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Securements: SS wire bands at 300 mm on centre.

- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.
- .5 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .6 TIAC Code: A-2.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-H.
- .7 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.
 - .3

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38
Domestic HWS		[A-1]	25	25	25	38	38
Domestic CWS with vapour retarder		[C-2]	25	25	25	25	25
Refrigerant	4 - 13	[A-6]	25	25	25	25	25
Refrigerant	below 4	[A-6]	25	25	38	38	38
RWL and RWP		[C-2]	25	25	25	25	25
Cooling Coil cond. drain		[C-2]	25	25	25	25	25

- .8 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: PVC jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Outdoors: water-proof aluminum jacket.
 - .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 **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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 Cleaning And Start-Up Of Mechanical Piping Systems

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.3 Hydronic Systems - Performance Verification (Pv)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

1.4 Hydronic System Capacity Test

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully radiation control valves.

1.5 Sanitary And Storm Drainage Systems

- .1 Ensure that traps are fully and permanently primed.

- .2 Ensure that fixtures are properly anchored, connected to system.

1.6 Reports

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

1.7 Training

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified herein.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not Used.

PART 3 EXECUTION

3.1 Not Used

- .1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
 - .2 Clean all new piping installed. Create a temporary piping loops to permit flushing of only new piping and terminal units.
- .2 Related Requirements

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 Quality Assurance

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Cleaning Solutions

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Cleaning Hydronic And Steam Systems

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Add chemicals under direct supervision of chemical treatment supplier.
 - .3 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .4 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .5 Add chemical solution to system.
 - .6 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

3.3 Start-Up Of Hydronic Systems

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation.
 - .2 Ensure air is removed.
 - .3 Clean out strainers repeatedly until system is clean.
 - .4 Bring system up to pressure slowly over a 48 hour period.
 - .5 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Adjust pipe supports, hangers, and springs as necessary.
 - .7 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .8 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .9 Check operation of drain valves.
 - .10 Adjust valve stem packings as systems settle down.
 - .11 Fully open balancing valves (except those that are factory-set).
 - .12 Check operation of over-temperature protection devices on circulating pumps.
 - .13 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 ASTM International
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M, Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 CSA Group
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

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 specified 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 hydronic specialties for incorporation into manual.
- .3 Submit 2 copies of operation and maintenance manual.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.

- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Automatic Air Vent

- .1 Install on each convector, fan coil or cabinet unit heater.
- .2 Radiator vent: brass body and insert, NPS 1/8 connection, screw driver operated, with copper tube extensions.
- .3 Steel panel radiator vent: chrome plated, automatic type.
- .4 Standard float vent: brass body and NPS 1/8 connection and rated at 620 kPa working pressure.
- .5 Install float vent on heating and chilled water at system high points. Install isolation valve ahead of air vents, except on coils equipped with isolation valves.
- .6 On glycol, install key-operated air vents at all high points and as indicated.

2.2 Combination Separators/Strainers

- .1 Steel, tested and stamped in accordance with ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.3 Combination Low Pressure Relief And Reducing Valve

- .1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

2.4 Pipe Line Strainer

- .1 NPS 1/2 to 2, Class 125: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 1/2 to 12, Class 125: cast iron body to ASTM A48, Class 30, flat faced flanged connections.
- .3 Blow down connection.
- .4 Screen: stainless steel with
 - .1 Up to 50mm: 0.79 mm perforations.
 - .2 64mm and 200mm: 1.6 mm
- .5 Working pressure: 860 kPa.

2.5 Auxilliary Test Ports

- .1 Instrument test ports for reading of temperature and pressure via insertion probe. NPT 1/4 brass body with cap, self-sealing neoprene valve core. Length to suit application.

PART 3 EXECUTION

3.1 General

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Run drain lines and blow off connections to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

3.2 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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.3 Application

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.4 Strainers

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and ahead of control valves smaller than NPS 1 that are not full port (such as those equipped with characterizing discs).

3.5 Air Vents

- .1 Install at high points of systems.
- .2 Install valve on automatic air vent inlet.

3.6 Dielectric Unions

- .1 Install at connection of dissimilar metals.
- .2 Metals that are adjacent on the galvanic scale may not require additional protection, subject to the approval of the Engineer.
- .3 Dielectric 'couplings' are not acceptable.

3.7 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
 - .2 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 ASME
 - .1 ASME B16.22, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.
 - .3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5, Refrigeration Piping and Heat Transfer Components.
- .2 ASTM International
 - .1 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .2 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 CSA Group
 - .1 CSA B52, B52 Package, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

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 refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittal.
- .2 Operation and Maintenance Data: submit operation and maintenance data for refrigerant piping for incorporation into manual.
- .3 Submit copies of operation and maintenance manual.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Tubing

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
 - .1 Hard copper: to ASTM B280, type ACR.
 - .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 Fittings

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 15% Ag-80% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 Pipe Sleeves

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 Valves

- .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

- .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Manufacturer's Instructions

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

3.3 General

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05 - Installation of Pipework.

3.4 Brazing Procedures

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

3.5 Piping Installation

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction
 - .2 Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
 - .3 Provide inverted deep trap at top of risers.
 - .4 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m³/s at minimum load. Connect upstream of traps on large riser.

3.6 Pressure And Leak Testing

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.
- .3 Test procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.7 Field Quality Control

- .1 Site Tests/Inspection:
 - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 hours.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 hours.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
- .7 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements to Departmental Representative.

3.8 Demonstration

- .1 Instructions:

- .1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

3.9 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 Summary

1.2 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE Handbook – Fundamentals.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/ULC-S109M, Standard for Flame Tests of Flame-Resistant Fabrics and Films.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 HVAC Duct Construction Standards - Metal and Flexible.
 - .2 HVAC Air Duct Leakage Test Manual.

1.3 Shop Drawings And Product Data

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

1.4 Closeout Submittals

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

PART 2 PRODUCTS

2.1 Galvanized Steel

- .1 Lock forming quality: to ASTM A653/A653M, G90/Z275 zinc coating, with tolerances to ASTM A924/A924M.
- .2 Thickness, fabrication and reinforcement: to SMACNA HVAC Duct Construction Standards.
- .3 Joints: to SMACNA HVAC Duct Construction Standards.

2.2 Pressure Classification

- .1 Pressure Class: to match maximum design external static pressure of fans systems.

2.3 Ductwork

- .1 Construction - round and oval.
 - .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA HVAC Duct Construction Standards.
 - .2 Transverse joints up to 900 mm: slip type with tape and sealants.
 - .3 Transverse joints over 900 mm: Vanstone flanges.
- .2 Construction - rectangular:
 - .1 Ducts: factory fabricated to SMACNA HVAC Duct Construction Standards.
 - .2 Transverse joints: to SMACNA HVAC Duct Construction Standards.

2.4 Fittings

- .1 Fabrication: to SMACNA HVAC Duct Construction Standards.
- .2 Radiused elbows:
 - .1 Rectangular: smooth radius. Centreline radius: 1.5 times width of duct.
 - .2 Round and oval: smooth radius or five-piece (for 90 degrees) and three-piece (for 45 degrees). Centreline radius: 1.5 times duct diameter.
- .3 Mitred elbows:
 - .1 To 750 mm duct height in plane of turn: with single-thickness turning vanes.
 - .2 Over 750 mm duct height in plane of turn: with double-thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: connection with 45 degree entry.
 - .2 Round main and branch: conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
- .5 Transitions:
 - .1 Diverging: 10 degrees maximum angle each side; 20 degrees maximum included angle for symmetrical fittings.
 - .2 Converging: 22.5 degrees maximum angle each side; 45 degrees maximum included angle for symmetrical fittings.
- .6 Offsets:
 - .1 Full radiused or mitred elbows: as specified above.
- .7 Obstruction deflectors: maintain full cross-sectional area of duct.
 - .1 Maximum included angles: as for transitions.

2.5 Seal Classification

- .1 Seal class:
 - .1 Refer to equipment specifications and schedules and match expected static pressures.
- .2 Seal Classification:

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

2.6 Sealant

- .1 Sealant: oil resistant, water-based, polymer type flame resistant duct sealant.
- .2 Flame spread rating shall not exceed 25 and smoke developed classification shall not exceed 50.
- .3 Operational temperature range of minus 32 degree C to plus 93 degree C. Application temperature range of plus 4 degree C to plus 43 degree C.

2.7 Reinforcing Tape

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
- .2 Meets the flame-resistance requirements of CAN/ULC-S109M.

2.8 Hangers And Supports

- .1 Hangers and Supports:
 - .1 Hanger configuration, design, and construction: to SMACNA HVAC Duct Construction Standards.
 - .2 Strap hangers: Maximum rectangular duct size supported by strap hanger: 500 mm on longest side.
 - .1 Straps of same material as duct but next sheet metal thickness heavier than duct.
 - .2 Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - .3 Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - .3 Band hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum round or oval duct size supported by strap hanger: 500mm diameter.
 - .4 Trapeze hangers and Riser Supports: ducts over 500 mm diameter or longest side, to SMACNA HVAC Duct Construction Standards.
 - .1 Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - .2 Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - .3 Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.
 - .5 Hangers: galvanized steel angle with galvanized steel rods to SMACNA HVAC Duct Construction Standards.
 - .6 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.

- .2 For steel joist: manufactured joist clamps.
- .3 For steel beams: manufactured beam clamps.
- .7 Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

PART 3 EXECUTION

3.1 General

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standards unless directed otherwise by Engineer.
- .2 First class workmanship is required for fabrication and installation. Submit samples and/or detailed shop drawings of different types of fittings, joints, supports, sealants, etc, when requested by the Engineer.
- .3 Locate ductwork approximately as shown on drawings unless otherwise prevented by jobsite conditions. Carefully coordinate duct layouts with other services, particularly where exposed in occupied spaces. Conceal all ductwork unless otherwise directed and approved by the Engineer. Report all layout deviations to the Engineer for approval prior to installation.
- .4 Construct ducts in accordance with the dimensions shown on the drawings. Alter the duct dimensions, while maintaining the equivalent round duct diameter, where necessitated by jobsite conditions. Equivalent duct dimensions to be determined using ASHRAE Handbook duct design procedures.
- .5 Duct dimension shown on drawings are inside dimensions. If ducts are internally lined or insulated, increase duct size such that clear dimensions after application of lining/insulation are equal to those shown on drawings.
- .6 Adjust duct dimensions to suit standard control damper sizes.
- .7 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .8 Support risers at each floor penetration. Provide neoprene pads between riser supports and the building structure. On exposed ductwork, provide galvanized angle collars to conceal the above work on both sides of the floor penetration.
- .9 Lap all joints in the direction of air flow wherever possible.
- .10 Provide a smooth interior surface at all seams and joints.
- .11 Provide a straight collar, not less than 300 mm long, at the connection to each diffuser. Where this is not possible provide adjustable multi-blade type flow equalizing grid in the diffuser neck.

3.2 Fittings

- .1 Fitting geometry to be in accordance with specifications and drawing details unless otherwise directed and approved by the Engineer.

- .2 Provide mitred elbows with turning vanes where jobsite conditions prevent installation of radiused elbows.

3.3 Hangers

- .1 Strap and band hangers: install in accordance with SMACNA HVAC Duct Construction Standards.
- .2 Angle hangers: install in accordance with SMACNA HVAC Duct Construction Standards, complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA HVAC Duct Construction Standards.
- .4 Do not break continuity of insulation vapour barrier with hangers or rods.

3.4 Sealing And Taping

- .1 Apply sealant to outside of joint in accordance with SMACNA HVAC Duct Construction Standards and to manufacturer's recommendations.
- .2 Use reinforcing tape on all ducts with seal Class A; ducts with seal Class B or C and a pressure classification in excess of 500 Pa; and for larger gaps.
- .3 Bed reinforcing tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.
- .4 Seal all joints including, but not limited to, at coils, terminal units, grilles and diffusers.
- .5 Eliminate all audible noise caused by air leakage.

3.5 Watertight Duct And Drip Pans

- .1 Provide watertight duct for:
 - .1 Intake and relief air outlets.
 - .1 Ductwork connect from ERV unit to outdoors
 - .2 Outside air intakes.
 - .3 In supply ducts with humidification distributor, minimum 3 m down stream and 1m upstream of distribution manifold.
 - .4 As directed by Engineer.
- .2 Provide watertight evaporative pan below:
 - .1 Intake and relief air outlets.
 - .1 Beneath roof hoods for ERV unit
- .3 Form bottom of horizontal duct or drip pan without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .4 Slope horizontal branch ductwork down towards hoods served.
 - .1 Slope header ducts down toward risers.

- .5 Fit base of riser with 150 mm deep drain sump and 25 mm drain, with deep seal trap and trap primer, discharging to open funnel or hub drain.
- .6 Drip pan to be 75 mm wider all around ductwork or equipment served and complete with 75 mm deep drain sump. Elevated drip pans to be provided with 25 mm drain discharging to open funnel or hub drain. Provide sufficient clearance above drip pan to facilitate access and to permit unimpeded airflow to equipment or intake above.
- .7 Provide angle iron supports under sumps and drip pans adequate to support weight when full.
- .8 Install drip pans level to maximize holding capacity.
- .9 Fill sumps and drip pans with water to demonstrate strength, level and waterproof, when requested by Engineer.

3.6 Leakage Tests

- .1 Conduct tests in accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- .3 Coordinate testing requirements with the TAB contractor who will perform leakage tests. Provide temporary caps and make duct modifications required to conduct the tests.
- .4 Do leakage tests in sections.
- .5 Leakage testing shall include HVAC equipment and terminal units. Where sections include equipment and terminal units, do not perform leakage testing until final connections have been made.
- .6 Conduct trial leakage tests to demonstrate workmanship.
- .7 Do not install additional ductwork until trial tests have been passed.
- .8 Complete testing before installation of insulation or concealment Work.
- .9 Give seven days' advance notice for testing.

END OF SECTION

PART 1 GENERAL

1.1 References

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

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 [air duct accessories] and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 General

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

2.2 Flexible Connections

- .1 Frame: galvanized sheet metal frame thick with fabric clenched by means of double locked seams.
- .2 Material:

- .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

2.3 Access Doors In Ducts

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
 - .6 300 x 300 mm glass viewing panels.

2.4 Turning Vanes

- .1 Factory or shop fabricated double thickness with trailing edge, 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.

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.

2.7 Duct Security Bars

- .1 Refer to architectural drawings for secure walls. Provide in all duct penetrations in these walls greater than 152x152mm whether indicated on mechanical plans or not.
- .2 Furnish and install duct / barrier grille of the sizes and mounting types indicated on the plans. 5 mm sleeve with two 25 x 25 x 5mm 4-sided angle frames (one frame welded 25mm from one end, one frame shipped loose for field welding). Barrier bars shall be 13mm hot rolled steel bars located on maximum 152 x 152 mm centers. Bars are to be welded to frame and at all crosspoints. The grille shall be painted with a powder coat process and be finished in white.

2.1 Rated Silencers And Cross Talk Silencers

- .1 Refer to architectural drawings and wall types for require STC ratings of assemblies. Provide manufactured and rated silencers to match assemblies.

- .2 Provide rated cross talk silencers on all air transfer openings that penetrate STC rated walls. Rating of silencer to meet rating of wall or room.
- .3 Silencer performance characteristics, including insertion loss and pressure drop, shall be attained through testing in accordance with the latest ASTM E477 test standard for acoustical duct silencers. Laboratory performance verification in the manufacturer's test facility may be requested, in which case a comparative test report shall be made available to the engineer.
- .4 Silencers shall consist of 22 gauge solid steel casings, 26 gauge solid steel internal noses at inlet and outlet, and ¾ inch dual-density absorptive acoustic fiberglass media.
- .5 Acoustic media shall be shot-free inorganic gl. Acceptable methods of fastening include button lock, Pittsburgh lock and welds. In situations where these methods are not feasible, rivets can be used. Screws or other types of mechanical fasteners will not be acceptable. The silencer perforated liners shall be rigidly fastened to the casing of the silencer on both ends, and attached to the outer casing with a minimum of two stiffeners.
- .6 Combustion ratings for acoustic media shall be equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84, UL723 and NFPA255.
 - .1 Flame Spread Classification: < 25
 - .2 Smoke Development Rating: < 50
- .7 Silencers shall be custom configuration with multiple bends to suit on site conditions.

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.
 - .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 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .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.

- .2 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 900 x 900 mm for person size entry.
 - .2 600 x 600 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 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 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.
- .4 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 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 Waste Management: separate waste materials for reuse and recycling.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-[2013].

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 specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals:

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

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 General

- .1 Manufacture to SMACNA standards.

2.2 Splitter Dampers

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.

- .5 Pivot: piano hinge.
- .6 Folded leading edge.

2.3 Single Blade Dampers

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

2.4 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: 150 mm.
- .4 Maximum blade length: 1200 mm. Use multi-sectional dampers for applications exceeding 1200 mm.
- .5 Bearings: pin in bronze bushings or self-lubricating nylon.
- .6 Linkage: shaft extension to accommodate insulation thickness with locking quadrant.
- .7 Channel frame of same material as adjacent duct, complete with angle stop.
- .8 Vibration-free operation.

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.
 - .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 where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 ASTM International
 - .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 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 dampers 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 dampers 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.
- .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 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Multi-Leaf Dampers

- .1 Opposed blade type as indicated.
- .2 Structurally formed steel, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

- .5 Performance:
 - .1 Leakage: in closed position less than 2% of rated air flow at 250 Pa differential across damper.
- .6 Insulated aluminum dampers:
 - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.2 Disc Type Dampers

- .1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A653/A653M.
- .2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A653/A653M.
- .3 Gasket: extruded neoprene, field replaceable, with 10 year warranty.
- .4 Bearings: roller self lubricated and sealed.
- .5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
- .6 Performance:
 - .1 Leakage: in closed position less than 0.001% of rated air flow at 250 Pa pressure differential across damper.

2.3 Back Draft Dampers

- .1 Automatic gravity operated, multi, aluminum construction with nylon bearings, spring assisted or counterweighted.

2.4 Relief Dampers

- .1 Automatic multi-leaf steel dampers with ball bearing centre pivoted and counter-weights.

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.
 - .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 where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.

- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Air Movement & Control Association International Inc.
 - .1 AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
 - .2 AMCA Standard 511, Certified Ratings Program for Air Control Devices.
- .2 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
 - .2 ANSI/NFPA 80, Standard for Fire Doors and other Opening Protectives
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .3 ULC-S505, Standard for Fusible Links for Fire Protection Service.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals:

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

1.4 Additional Submittals

- .1 Shop drawing submissions shall include the following additional information:
 - .1 Schedule with the following data (as applicable) for each damper:
 - .1 Type and model number.
 - .2 Installed orientation.
 - .3 Size.
 - .4 Air flow rate and pressure drop.
 - .5 Fire resistance rating.
 - .6 Closure type and temperature rating.
 - .7 Smoke damper temperature rating and leakage class.
 - .2 Damper actuator details including mounting, failure position, electrical characteristics and wiring diagrams.
 - .3 Accessories: including associated electrical data and wiring diagrams.
 - .4 Manufacturer's installation instructions for each model.

1.5 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals\.
 - .2 Provide:
 - .1 6 fusible links of each type.

1.6 Certification Of Ratings

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency in adherence to all codes and standards required by the authority having jurisdiction.

1.7 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Fire Dampers

- .1 Fire dampers: listed and bear label of ULC, assemblies fire tested and rated in accordance with CAN/ULC-S112, meet requirements of authorities having jurisdiction.
- .2 Classified for dynamic closure against maximum design airflow, at 2000 Pa minimum static pressure differential (across closed damper), for installed configurations and locations on systems where fan does not shut down on fire alarm.
- .3 Factory fabricated for fire resistance rating requirement and installation orientation to maintain integrity of fire wall and/or fire separation.
- .4 Curtain-type design: steel frame with reinforced corners, steel interlocking blades, sheet steel mounting sleeve (factory or field installed), transitions to suit connecting ductwork. Galvanized steel construction where connecting ductwork is galvanized, stainless steel construction where connecting ductwork is stainless steel. Provide sealed high pressure construction where duct pressure class exceeds 500 Pa or Class B or C duct seal is specified.
- .5 Closure type: fusible link actuated, weighted to close and lock in closed position when released or having stainless steel negator-type spring closing operator for damper in horizontal position with vertical air flow. Generally fusible links to be rated at 74EC for exhaust and recirculation applications, and 100EC on supply air applications. Revise,

with Engineer's approval, as required to meet the needs of special locations. Fusible links shall be readily removable by hand to facilitate testing.

- .6 Damper types and transition collars to be selected based on the following criteria unless otherwise directed by the Engineer:
 - .1 Duct pressure class less than or equal to 500 Pa, unsealed or Class C duct seal, and face velocities less than or equal to 15 m/s:
 - .1 Type A: square and rectangular ductwork with air velocities less than or equal to 5 m/s and aspect ratios of 2:1 or less.
 - .2 Type B: square and rectangular ductwork with air velocities exceeding 5 m/s or aspect ratios greater than 2:1.
 - .3 Type R: round ductwork.
 - .2 Duct pressure class greater than 500 Pa, Class B duct seal, or face velocities exceeding 15 m/s:
 - .1 Type C: square and rectangular ductwork.
 - .2 Type CO: flat oval ductwork.
 - .3 Type CR: round ductwork.
- .7 Factory tested for proper operation.

2.2 Smoke Dampers

- .1 Smoke dampers: listed and bear label of ULC, assemblies fire tested and rated in accordance with CAN4-S112.1, meet requirements of authorities having jurisdiction, licensed to bear the AMCA seal, assemblies tested and rated in accordance with AMCA Standards 500-D and 511.
- .2 Factory fabricated for installation orientation to maintain integrity of smoke separation.
- .3 Temperature rating: 177°C.
- .4 Leakage rating: Class I - leakage shall not exceed 40 L/s-m² at 1000 Pa minimum static pressure differential (across closed damper).
- .5 Multi-blade design: steel frame with reinforced corners and low profile head and sill, steel blades, square plated steel axles, bronze sleeve type bearings, flexible stainless steel jamb seals, pressure sensitive silicone blade edge seals, plated steel linkage concealed in frame, factory installed steel mounting sleeve, transition collars to suit connecting ductwork. Galvanized steel construction where connecting ductwork is galvanized, stainless steel construction where connecting ductwork is stainless steel. Frame leakage not to exceed that of connecting ductwork.
- .6 Blade style and operation:
 - .1 Three-V style with parallel blade operation for face velocities less than or equal to 7 m/s, two-position (fully open or fully closed) operation, and where even airflow distribution is not required downstream of open damper.
 - .2 Airfoil-shaped, double-thickness style with opposed blade operation for face velocities exceeding 7 m/s, modulating operation, ducted outlets, or upstream of system components requiring even airflow distribution.
- .7 Actuator: electric, controlled from smoke sensor or smoke detection system, spring return, fail to normally closed position, EEMAC Type 4 enclosure, factory installed on outside of damper mounting sleeve, factory wired to a single junction box for single-point wiring connection. All actuators to be provided by a single manufacturer. Confirm power supply characteristics prior to ordering.

- .8 Accessories: package for remote indication of damper position complete with switch box, two 120 V rated micro switches (one closes when the damper is fully open and the other closes when the damper is fully closed), switch box mounting bracket, blade bracket and connecting hardware.
- .9 Smoke dampers under 400 mm high shall be oversized by 50 mm (width and height) and provided with Type C enclosures with transition collars to suit connecting duct size to maximize free area.
- .10 Factory tested for proper operation.

2.3 Combination Fire/Smoke Dampers

- .1 Combination fire/smoke dampers: listed and bear labels of ULC for both fire and smoke dampers, assemblies fire tested and rated in accordance with CAN/ULC-S112 and CAN/ULC-S112.1, meet requirements of authorities having jurisdiction, licensed to bear the AMCA seal, assemblies tested and rated in accordance with AMCA Standards 500-D and 511.
- .2 Damper: similar in all respects to smoke dampers specified above and incorporating required fire damper performance and rating.
- .3 Combined actuator: electric, similar in all respects to smoke dampers specified above, controlled from smoke sensor or smoke detection system and from fusible link.
- .4 Factory tested for proper operation.

2.4 Firestop Flaps

- .1 Firestop flaps: listed and bear label of ULC, assemblies fire tested and rated in accordance with CAN4-S112.2, meet requirements of authorities having jurisdiction.
- .2 Factory fabricated for fire resistance rating requirement to maintain integrity of fire separation.
- .3 Galvanized steel frame and blades, non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .4 Flaps to be held open with fusible link conforming to ULC-S505. Generally fusible links to be rated at 74 degrees C on exhaust and recirculation air ducts, and 100 degrees C on supply air ducts. Revise, with Engineer's approval, as required to meet the needs of special locations. Fusible links shall be readily removable by hand to facilitate testing.
- .5 Factory tested for proper operation.

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.
 - .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 Refer to Architectural drawings for locations and ratings of fire and smoke separations. Provide dampers and firestop flaps of approved types in all duct penetrations of fire and smoke separations.
- .2 Review all damper and firestop flap locations and requirements with Engineer early in the project.
- .3 Install in accordance with ANSI/NFPA 90A, requirements of authorities having jurisdiction, and in strict accordance with conditions of ULC listing. Maintain integrity of fire and smoke separations.
- .4 Install and test in accordance with NFPA 80.
- .5 Install break-away joints of approved design on each side of fire separation unless otherwise directed by Engineer.
- .6 Coordinate with TAB contractor early in the project. Review locations and access requirements of all dampers and firestop flaps to facilitate testing.
- .7 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .8 Provide access door adjacent to each damper.
- .9 Coordinate with installer of firestopping. Any firestopping required by local codes or authorities having jurisdiction shall be done in strict accordance with conditions of ULC listing using approved materials. Fire stop in accordance with manufacturer's installation instructions.
- .10 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible for inspection, testing and replacement.
- .11 Identify all dampers and firestop flaps clearly and accurately on project record drawings.

3.3 Testing

- .1 Test for proper operation of all smoke and fire dampers, sensors, detectors, [] installed as component parts of air systems specified Division 23.
- .2 Test each fire damper by releasing it twice so as to check whether the damper is binding and is operating in accordance with requirements of the authority having jurisdiction. Reset dampers in accordance with manufacture's directions. Resolve all problems and then re-test, until satisfactory result is achieved. Permanently mark all dampers with an identification number which shall also appear on the "as-built" drawings. Submit a test report to the Engineer, listing the following data:
 - .1 Identification of each fire damper corresponding with the "as-built" drawings.
 - .2 Test results of each damper, including access problems.
 - .3 Repair procedures, if any, to each damper if not properly working.
 - .4 State the date of the check(s).
 - .5 Name of company and checker(s).
- .3 Affix tag to duct adjacent fire and smoke dampers indicating date of test, TAB company name and contact info, technician initials.
- .4 Include a complete copy of the written report in each Operating/Maintenance Manual.
- .5 Confirm closure of smoke and combination fire/smoke dampers on during fire alarm condition and power failure.

- .6 Confirm proper operation of smoke dampers and combination fire smoke dampers according to specified sequences of operation, including manual overrides and safeties.

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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Air Diffusion Council (ADC).
 - .1 Flexible Duct Performance & Installation Standards.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .6 Underwriters' Laboratories (UL)
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110, Standard Methods of Tests for Air Ducts.

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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Test and Evaluation Reports:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 General

- .1 Factory fabricated Class 1 flexible air ducts conforming to the requirements UL 181 and CAN/ULC-S110.
- .2 Joint mastics and tapes: listed and labelled in accordance with UL 181B and complying with CAN/ULC-S110.
- .3 Duct clamps: stainless steel construction with worm gear operators.
- .4 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .5 Flame spread rating not to exceed 25. Smoke developed classification not to exceed 50.
- .6 Thermal resistance properties determined in accordance with ADC Flexible Duct Performance & Installation Standards using ASTM C518. Products shall bear the ADC Seal of Certification.

2.2 Non-Metallic – Uninsulated

- .1 Type NM-UN: non-collapsible, heavy duty vinyl-impregnated woven fibreglass cloth permanently bonded to, and supported by, corrosion resistant spring steel wire helix.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Operating static pressure limits: 2.5 kPa positive, 0.25 kPa negative.
 - .3 Maximum relative pressure drop coefficient: 2.

2.3 Non-Metallic – Insulated (Lined)

- .1 Type NM-IL: non-collapsible, chlorinated polyethylene core (CPE) core permanently bonded to, and supported by, corrosion resistant spring steel wire helix with factory applied flexible mineral fibre acoustic insulation and encased in metallized polyester film (MPF) vapour barrier jacket reinforced with fibreglass scrim.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.

- .2 Operating static pressure limits: 2.5 kPa positive, 0.25 kPa negative.
- .3 Maximum relative pressure drop coefficient: 2.
- .4 Thermal resistance: 0.74 W/m²-degrees C mean.
- .5 Acoustical performance: Minimum insertion loss (dB/m of straight duct @ no flow) to following table:

Duct Diam:	Frequency (Hz)				
(mm)	125	250	500	1000	2000
150	4.9	6.6	11.8	12.8	12.8
200	2.6	3.9	9.5	11.5	11.8
300	6.6	8.5	8.5	11.5	9.8

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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed With Installation Only After Unacceptable Conditions Have Been Remedied

3.2 Duct Installation

- .1 Install in accordance with SMACNA and ADC standards.
- .2 Joints shall be made up using mastic and duct clamps. The use of adhesive tape is not permitted.
 - .1 Refer to 23 31 13 for joint sealant requirements.
- .3 Use to accommodate misalignment of branch ducts and diffusers. Provide type NM-IL flexible duct where connecting rigid duct is insulated internally or externally. Provide type NM-UN flexible duct where connecting rigid duct is not insulated.
- .4 Maximum length at each diffuser: 1,000 mm.
- .5 Maximum turn allowed: 30°. Otherwise use a rigid elbow.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 ASTM International
 - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .3 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA AH116, Fibrous Glass Duct Construction Standards.
- .4 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 Under Construction.
- .5 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals:

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

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Duct Liner

- .1 General:
 - .1 Mineral fibre duct liner: air surface coated with smooth matt acrylic polymer.
 - .2 Temperature limit: 121EC.
 - .3 Flame spread rating shall not exceed 25 and smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
 - .4 Water sorption: less than 3% by weight when tested in accordance with ASTM C1104.
 - .5 Fungi resistance: to ASTM C1338 and ASTM G21.
- .2 Rigid:
 - .1 Use on flat surfaces.
 - .2 25 mm thick, to ASTM C1071, Type II, fibrous glass rigid board duct liner.
 - .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m². °C)/W for 25 mm thickness when tested in accordance with ASTM C177 or C518, at 24EC mean temperature.
 - .5 Maximum velocity on faced air side: 30 m/sec.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type "A" mounting to ASTM C423.
- .3 Flexible:
 - .1 Use on round or oval surfaces and where otherwise directed by Engineer.
 - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.74 (m². °C)/W for 25 mm thickness when tested in accordance with ASTM C177 or C518, at 24EC mean temperature.
 - .5 Maximum velocity on coated air side: 30 m/sec.
 - .6 Minimum NRC of 0.65 at 25 mm thickness based on Type "A" mounting to ASTM C423.

2.2 Adhesive And Sealant

- .1 Adhesive and sealant: to ASTM C916.

- .2 Flame spread rating shall not exceed 25 and smoke developed classification shall not exceed 50. Temperature range minus 29EC to plus 93EC.
- .3 Water-based fire retardant type.

2.3 Fasteners

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

2.4 Joint Tape

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 Sealer

- .1 Meet requirements of NFPA 90A.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 General

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standards except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.3 Duct Liner

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 450 mm on centres to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with NAIMA AH124, Fibrous Glass Duct Liner Standard.
- .2 All joints to be tightly butted together with no interruptions or gaps.

- .3 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner.
- .4 Replace damaged areas of liner at discretion of Engineer.
- .5 Provide metal nosing over transverse oriented liner edges facing the airstream at the discharge of fans, at any section of lined duct preceded by unlined duct and where the continuity of liner is interrupted by duct mounted devices (e.g. fire dampers, coils).
- .6 Where duct air velocities exceed 20 m/sec provide sheet metal nosing on the leading edge of duct liner at every transverse joint.
- .7 Turning vane assemblies, dampers and other devices located inside lined ductwork shall be installed using insulated "build outs" secured to the duct wall.

3.4 Joints

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply 2 coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Departmental Representative.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

3.5 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 99, Standards Handbook.
 - .2 ANSI/AMCA Standard 210/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

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 HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide:
 - .1 Fan performance curves showing point of operation, bhp and efficiency.
 - .2 Sound rating data at point of operation.
 - .2 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers where applicable.

1.3 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Provide:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

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 in force.
 - .2 Capacity: flow rate, static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.
 - .4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. [Supply unit with ANSI/AMCA certified sound rating seal].
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. [Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter].

2.2 Direct Drive Premium Inline Cabinet Centrifugal Exhaust Fans

- .1 General Description:
 - .1 Inline mounted applications
 - .2 Maximum operating temperature is 130 Fahrenheit (54.4 Celsius)
 - .3 Fans are UL/cUL listed 507 - Electric Fans
 - .4 Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number
- .2 Wheel:
 - .1 Forward curved centrifugal wheel
 - .2 Constructed of galvanized steel or calcium carbonate filled polypropylene
 - .3 Statically and dynamically balanced in accordance to AMCA Standard 204-05
- .3 Motors:
 - .1 AC Induction Motor
 - .1 Motor enclosures: Open drip proof (ODP) - opening in the frame body and or end brackets

- .2 Motors shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
 - .3 Motor shall be mounted on vibration isolators and be accessible for maintenance
 - .4 Compatible for use with speed controls
 - .5 Thermal overload Protection
- .4 Housing:
 - .1 Constructed of heavy gauge galvanized steel
 - .2 Interior shall be lined with 0.5 inches of acoustical insulation
- .5 Spring Loaded Aluminum Backdraft Damper:
 - .1 Prevents air from entering back into the building when fan is off
 - .2 Eliminates rattling or unwanted backdrafts
- .6 Outlet:
 - .1 Type of outlet: Square
 - .2 Field rotatable from horizontal to vertical discharge
 - .3 Shall include an aluminum backdraft damper
- .7 External Electrical Accessories:
 - .1 Eliminates removing the motor pack which saves time on installation
- .8 Mounting Brackets:
 - .1 Fully adjustable for multiple installation conditions
- .9 Access Panel:
 - .1 Once installed shall have easy access to internal components
- .10 Control:
 - .1 Provide speed controller, wall mounted for occupant control.

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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Fan Installation

- .1 Install fans as indicated.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.

- .4 Access doors and access panels to be easily accessible.

3.3 Anchor Bolts And Templates

- .1 Size anchor bolts to withstand and velocity forces anticipated

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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 210/(ANSI/ASHRAE 51), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .2 International Organization of Standardization (ISO)
 - .1 ISO 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .4 Underwriter's Laboratories (UL)
 - .1 UL 181, Factory-Made Air Ducts and Air Connectors.

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 air terminal units and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate the following:
 - .1 Capacity.
 - .2 Pressure drop.
 - .3 Noise rating.
 - .4 Leakage.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test and Evaluation Reports:
 - .1 Test data: to ANSI/AMCA Standard 210
 - .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
 - .2 Sound power level with minimum inlet pressure of 0.25 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
 - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

1.3 Closeout Submittals:

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

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

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 certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

2.2 Manufactured Units

- .1 Terminal units of the same type to be product of one manufacturer.

2.3 Single Duct Variable Air Volume Terminal Units

- .1 Pressure independent and shall reset to any airflow rate between zero and the maximum catalogued airflow rate.
- .2 At an inlet air velocity of 10 m/s, the static pressure drop across any unit with
- .3 Casing: constructed of 0.85 mm thick galvanized steel with inlet connection bead and outlet with slip and drive connections. Internally lined with 13 mm, 0.7 kg density matt-faced fibreglass insulation that complies with UL181 and ANSI/NFPA 90A. All insulation edges exposed to the air stream shall be coated with NFPA 90A approved sealant. Suitable for inlet static pressures up to 1500 Pa. Casing air leakage rates shall not exceed the values listed in the following table:

Unit Size:	Maximum Casing Leakage (L/s) at Listed Static Pressure				
	62 Pa	125 Pa	250 Pa	750 Pa	1500 Pa
5, 6	0.5	0.9	1.4	3.3	4.7
7, 8	0.5	0.9	1.4	3.3	4.7
9, 10	0.5	0.9	1.4	3.3	4.7
12	0.5	0.9	1.4	3.3	5.7

- .4 Primary air valve damper: heavy gauge galvanized steel with peripheral gasket, solid steel shaft and self-lubricating bearings. Air leakage past closed damper shall not exceed 2% of nominal catalogue rating at 750 Pa inlet static pressure, when tested in accordance with ANSI/ASHRAE 130.
- .5 Airflow sensor: aerodynamic cross configuration located the assembly inlet to traverse the duct using the equal cross sectional area or log-linear traverse method along two perpendicular diameters. The sensor shall have a minimum of 12 total pressure sensing ports, 4 static pressure sensing ports, center averaging chamber and gauge taps. Sensor accuracy shall be within 5% of rated airflow with a 90° sheet metal elbow located directly at the inlet of the assembly. The sensor shall output an amplified differential pressure signal of 7.5 Pa at assembly air inlet velocities < 2.3 m/s. Output differential signals shall fall within the standard 0 - 250 Pa range of most transducers and flow controllers.
- .6 Controls: damper actuator, A/D transducer and DDC controller to be supplied by the Controls Subcontractor to the terminal unit manufacturer for installation. All controls components shall be factory mounted, wired and calibrated per the controls contractor's documentation. All control components shall be located inside a protective metal enclosure provided by the terminal unit manufacturer; refer to drawings for enclosure location. Compatibility of the proposed A/D transducer and DDC controller with the airflow sensor shall be verified by the Controls Subcontractor prior to bidding the Project.
- .7 Sound attenuators: integral extension of the unit casing or a separate section with slip and drive connections. Construction and internal lining as per unit casing. Length and outlet arrangement as scheduled and indicated on the drawings.

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.
 - .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 manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate controls, dampers and access panels for easy access.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE Standard 70, Method of Testing for Rating the Performance of Air

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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.3 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

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 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as per schedule.

2.3 Manufactured Units

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

2.4 Diffusers, Grilles And Registers

- .1 Refer to schedule.
- .2 General requirements:
 - .1 To meet the features, capacity, pressure drop, terminal velocity, throw, noise level, and neck velocity of the scheduled product.
 - .2 Frames:
 - .1 Appropriate to surrounding construction material.
 - .2 Plaster frames where set into plaster or gypsum board and where otherwise specified.
 - .3 Full perimeter gaskets.
 - .4 Concealed fasteners.
 - .3 Concealed manual volume control damper operators.
 - .4 Flow Equalizing Grids: provide in the neck of all ceiling diffusers.
 - .5 Colour: baked off-white epoxy enamel unless otherwise directed by the Engineer.
 - .6 Grilles, registers and diffusers of same generic type to be the product of one manufacturer.
- .3 Features and performance: as scheduled. Scheduled characteristics govern where they conflict with the general requirements herein.
- .4 Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.
- .5 Double deflection steel supply grilles of the sizes and mounting types indicated on the plans and outlet schedule. Grilles shall be double deflection type with two sets of fully

- adjustable deflection blades spaced 3/4 in. (19) on center. The front set of blades shall run parallel to the long dimension of the grille, as indicated in the outlet schedule. The grille shall be finished in B12 White Powder Coat / B15 Aluminum Powder Coat.
- .6 Square plaque steel, ceiling diffusers of sizes and mounting types designated by the plans and air distribution schedule. Diffusers shall be steel construction, and shall consist of a seamless, one-piece, precision formed backpan that incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct. An inner plaque assembly shall be incorporated and shall drop no more than 1/4 inch below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the room side to allow for full access to any dampers or other ductwork components located near the diffuser neck. The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit. The face panel shall have smooth edges and rounded corners to blend with the back cone. Finish shall be B12 white powder coat.
- .7 Round plaque steel, ceiling diffusers of the size and capacities shown on the plans and air distribution schedule. Diffusers shall consist of an outer cone of one-piece seamless construction that incorporates a round inlet. The exposed surface of the plaque shall be smooth and flat. The air flow discharge pattern shall be field adjustable from horizontal to vertical by repositioning the mounting screws to one of three locations. The plaque shall be easily removed to allow for full access to any dampers or other ductwork components located near the diffuser neck. Provide primer finish.
- .8 Exhaust, return, and transfer air grilles of the sizes and mounting types indicated on the plans and outlet schedule. Grilles shall be of aluminum construction, consisting of aluminum 1/2 in. x 1/2 in. x 1/2 in. (13 x 13 x 13) grid eggcrate core and an extruded aluminum border. The grille shall be finished in B12 White Powder Coat / B15 Aluminum Powder Coat.

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.
- .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 screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 CSA Group
 - .1 CSA C22.2 No.46, Electric Air-Heaters.

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 duct heaters and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit product data and include:
 - .1 Element support details.
 - .2 Heater: total kW rating, voltage, phase.
 - .3 Number of stages.
 - .4 Rating of stage: rating, voltage, phase.
 - .5 Heater element watt/density and maximum sheath temperature.
 - .6 Maximum discharge temperature.
 - .7 Unit support.
 - .8 Clearance from combustible materials.
 - .9 Internal components wiring diagrams.
 - .10 Minimum operating airflow.
 - .11 Pressure drop operating airflow.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Duct Heaters

- .1 Duct heaters: flange type.
- .2 Elements:
 - .1 Helical coils of nickel chrome alloy resistance wire.
 - .2 Finned tubular.
 - .3 Incoloy sheathed.
- .3 Staging:
 - .1 Staged heaters: balanced line current at each stage.
 - .2 Each stage: uniform face distribution.
- .4 Controls:
 - .1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring to thermostat and sail switch.
 - .2 Controls mounted in a CSA enclosure and to include:
 - .1 Control transformers.
 - .2 SCR controller.
 - .3 Where controls are mounted in heater, exercise care in mounting contactors to minimize switching noise transmission through ductwork.
 - .4 High temperature cutout and air proving switch.
- .5 Main isolation disconnect switch.

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.
 - .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 Make power and control connections to CSA C22.2 No.46.

3.3 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.

- .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.

3.4 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 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

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 energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test Reports:
 - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
 - .2 Provide confirmation of testing.
- .5 Manufacturers' Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.3 Maintenance Material Submittals

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Extra Materials:
 - .1 Furnish list of individual manufacturer's recommended spare parts for equipment include:
 - .1 Extra set of filters.
 - .2 List of specialized tools necessary for adjusting, repairing or replacing.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 General

- .1 Comply with ASHRAE 84.

2.2 Manufactured Units

- .1 Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, outdoor air intake weatherhood with metal mesh filters, energy core, motorized intake damper, motorized exhaust damper, frost control, bypass damper, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

2.3 Cabinet

- .1 Materials: Formed single wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - .1 Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
 - .2 Internal assemblies: 24 gauge, galvanized (G90) steel. Direct drive motor provided with a fabricated belly band for motor support.
- .2 Shall have factory-installed duct flanges on all duct openings.
- .3 Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - .1 Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - .1 Thickness: 1 inch (25 mm)
 - .2 Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - .3 Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
- .4 Energy Core: Energy core shall be of total enthalpy and shall be removable from the cabinet. The core shall consist of a galvanized steel framework (designed to produce laminar air flow through the core) and an energy core as specified. The core media shall be a corrugated hydroscopic resin in a galvanized steel framework and can be removable for servicing. The energy core is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060.
- .5 Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a direct driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.

- .6 Control panel / connections: Energy Core Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
- .7 Frost control: electric preheater.
- .8 Economizer Control: Bypass Damper
- .9 Motorized dampers / Exhaust Air, Intake Air, Motorized dampers of low leakage type shall be factory installed.

2.4 Blower Section

- .1 Blower section construction, Supply Air and Exhaust Air: Direct drive motor and blower shall be assembled with neoprene vibration isolation devices. Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.
- .2 Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- .3 Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
- .4 Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
- .5 Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.5 Motors

- .1 General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Minimum compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.
- .2 Motors shall be 60 cycle, 1 phase 208 volts.

2.6 Unit Controls

- .1 The unit shall be constructed so that it can be controlled by factory-supplied controllers, thermostats and sensors or it can be monitored and controlled by a Building Management System (BMS).
- .2 Interlock operation with call centre AC/CU system.

2.7 Filters

- .1 Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.

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.
 - .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 manufacturers recommendations.
- .2 Support independently of adjacent ductwork with flexible connections.
- .3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers.
- .4 Where condensate drain is required, pipe to nearest floor drain by gravity.
 - .1 If drainage by gravity is not possible, provide condensate lift pump.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .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 Section includes:
 - .1 Computer room air conditioners for UPS Room.

1.2 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1, Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .2 American Society for Testing and Materials (ASTM International)
 - .1 ASTM C547, Specification for Mineral Fibre Pipe Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-115.10, Disposable Air Filters For Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.15, High Efficiency, Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .5 Environment Canada, (EC)/Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2, Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate major components and accessories including sound power levels of units.
- .3 Type of refrigerant used.

1.4 Closeout Submittals

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

- .3 For refrigeration compressors, the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 5 years.
- .4 Contractor hereby warrants refrigeration compressors in accordance with GC 24, but for 5 years.

PART 2 PRODUCTS

2.1 Computer Room Air Conditioners, 5-Ton And Greater

.1 GENERAL

- .1 The precision Thermal Management system shall be factory-assembled unit. Standard 60Hz units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard, "CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment" and are marked with the CSA c-us logo. It shall be specifically designed for service from the front and right side of the unit. The system shall be designed for draw-through air arrangement to insure even air distribution to the entire face area of the coil.
- .2 The system shall be AHRI Certified™, the trusted mark of performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.
- .3 System type:
 - .1 Air flow arrangement: top discharge with factory plenum and grilles, front return
 - .2 Cooling: direct expansion.
 - .3 Condenser: air cooled, refrigerant.
- .4 Cooling and dehumidifying capacity, with fan heat extracted: based on computer room environment of 22C dry bulb and 50% R.H. plus or minus 1 degree C and 5% R.H., with minimum supply air temperature of 14 degrees C and minimum control dead-band of 3% R.H. separating humidification and dehumidification.
- .5 Unit controls shall not permit dehumidification and humidification to occur simultaneously.
- .6 Unit capacity: as indicated on schedules.

.2 CABINET

- .3 Heavy gauge galvanized steel construction, corrosion protected, 20 mm thick acoustic insulation, factory baked on external finish.
- .4 Cabinet to house: compressors, condensers, liquid receiver, cooling coil, reheat coil, fans, filters, humidifier, unit environmental control system, motor starters or contactors and electrical disconnect switch.
- .5 Provide adequate access to components for servicing as per manufacturers instructions.
- .6 Corrosion protected structural steel floor stand having adjustable feet and locking device on corners, vibration isolators.

.7 SUPPLY AND RETURN GRILLE

- .1 For up flow units, provide manufacturers supply air discharge plenum with grille
- .8 FAN(S)
 - .1 The unit shall be equipped with one plug fan: integral direct driven fan with backward-curved blades and electronically commutated DC motor; commonly referred to as EC fan. The fan speed shall be variable and automatically regulated by the Liebert iCOM through all modes of operation. The fan shall have a dedicated motor, fault monitoring circuitry, and speed controller, which shall provide a level of redundancy. The impeller shall be made of aluminum and dynamically balanced. The EC fan shall be located within the unit. The EC fan shall also provide greater energy savings than forward curved centrifugal fan and variable speed drives.
- .9 ELECTRIC REHEAT
 - .1 The 12 kW reheat shall be a low-watt density 304/304 stainless steel finned-tubular electric reheat. The reheat section shall include UL/CSA recognized safety switches to protect the system from overheating. The electric reheat shall be controlled in two stages. The reheat elements shall be accessible from the right side of the cabinet.
- .10 COMPRESSORS
 - .1 The compressor shall be an R-410A digital scroll-type with variable capacity operation from 20-100%, commonly known as a digital scroll. The compressor solenoid valve shall unload the digital scroll compressor to provide variable capacity operation. The compressor shall have a suction gas cooled motor, EPDM Rubber vibration isolators, internal thermal overloads, automatic reset high pressure switch with lockout after three failure occurrences, rota-lock service valves, low pressure transducer, and crankcase heater. The compressor shall be removable and serviceable from the front of the unit. The crankcase heater and a discharge check valve shall be provided for additional system protection from refrigerant migration during Off cycles.
 - .2 Single compressor with:
 - .1 Vibration isolators.
 - .2 Adjustable high and low pressure switches.
 - .3 Anti-slug device.
 - .4 Motor overload and over temperature protection pump down controls.
 - .5 Refrigerant service valves.
 - .6 Capacity controls.
- .11 COOLING COIL
 - .1 The direct-expansion, tilted-slab cooling coil shall be constructed of copper tubes and hydrophilic-coated aluminum fins. The hydrophilic coating shall significantly improve the speed of condensate drainage from the fins and shall provide superior water carryover resistance. One stainless steel condensate drain pan shall be provided.
 - .2 Aluminum fins, mechanically bonded to copper tubes, tested to 1.7 MPa, maximum face velocity 2.8 m/s, with stainless steel insulated condensate tray and drain connections.
 - .3 Direct expansion: with separate refrigerant circuit for each compressor.
 - .4 Cooling coil condensate drain pans: designed to avoid standing water, easily cleaned or removable for cleaning.

- .1 Drain connection with deep seal trap complete with trap seal primer.
- .12 FILTERS
 - .1 Prefilters: 25 mm flat, disposable type, to CAN/CGSB-115.10.
 - .2 Final filters: pleated type, to CAN/CGSB-115.15.
 - .1 Initial Dust Spot efficiency, 45%, to ASHRAE 52.
 - .3 Mounting: in corrosion resistant racks with service access.
- .13 HUMIDIFIER
 - .1 All units shall be capable of humidifying.
 - .2 Evaporative pan type: stainless steel construction, electric finned resistance element or infra-red heater, complete with automatic flush.
 - .3 Steam generator type: microprocessor control with disposable canister, latticed electrode heating elements complete with steam distributor.
 - .4 Location downstream of cooling coil with water level control, overflow and drain, strainer and automatic flush, CSA or ULC approved.
- .14 CONDENSER
 - .1 General
 - .1 The condenser shall be designed to reject waste heat to outdoor air and to control refrigerant head pressure as indoor equipment loading and outdoor ambient conditions change.
 - .2 The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.
 - .3 Standard 60Hz units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard "CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment" and shall be marked with the CSA c-us logo.
 - .4 The air-cooled condenser shall be a factory-assembled unit, complete with integral electrical panel, designed for outdoor installation. The condenser shall be a draw-through design.
 - .5 Condenser shall consist of microchannel condenser coil(s), propeller fan(s) direct-driven by individual fan motor(s), electrical controls, housing, and mounting legs. The air-cooled condenser shall provide positive refrigerant head pressure control to the indoor cooling unit by adjusting heat rejection capacity. Microchannel coils shall provide superior heat transfer, reduce air-side pressure drop, increase energy efficiency, and significantly reduce the system refrigerant volume required. EC fans and fan operating techniques shall reduced sound levels. Various methods shall be available to match indoor unit type, maximum outdoor design ambient and maximum sound requirements.
 - .6 A Locking-Type disconnect switch shall be factory-mounted and wired to the electrical panel and be capable of disrupting the flow of power to the unit and controlled via an externally mounted locking and lockable door handle. The locking disconnect shall be lockable in support of lockout/tagout safety programs.
 - .2 Cabinet
 - .1 The condenser cabinet shall be constructed of bright aluminum sheet and divided into individual fan sections by full width baffles. Internal structural support members, including coil support frame, shall be

galvanized steel for strength and corrosion resistance. Panel doors shall be provided on two sides of each coil/fan section to permit coil cleaning. An electrical panel shall be contained inside a factory-mounted NEMA 3R weatherproof electrical enclosure.

- .3 Condenser Coil
 - .1 Microchannel coils shall be constructed of aluminum microchannel tubes, fins, and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins, and aluminum headers shall be oven-brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance-welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak tested at a minimum of 300 psig (2068kPag). Hot gas and liquid lines shall be copper and shall be brazed using nitrogen gas flow to the stub pipes with spun-closed ends for customer piping connections. Complete coil/piping assembly shall be then filled and sealed with an inert gas holding charge for shipment.
- .4 Fan/Motor:
 - .1 The fan motor/blade assembly shall have an external rotor motor, fan blades and fan/finger guard. Fan blades shall be constructed of cast aluminum or glass-reinforced polymeric material. Fan guards shall be heavy gauge, close-meshed steel wire, coated with a black corrosion resistant finish. Fan terminal blocks shall be in an IP54 enclosure on the top of the fan motor. Fan assemblies shall be factory-balanced, tested before shipment and mounted securely to the condenser structure.
 - .2 The EC fan motors shall be electronically commutated for variable speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC fan motor shall have a built-in controller and communication module, linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.
- .5 Receiver Kit shall contain an insulated, heated receiver tank with sight glasses, mounting plate, mounting hardware, pressure relief valve, rota-lock valve for refrigerant charge isolation and piping assembly with head pressure operated three-way valve and check valve. Components shall be field-assembled to the condenser. The three-way valve shall sense refrigerant head pressure and adjust the flooding charge in the condenser coil to adjust the condenser heat rejection capacity. The Liebert Lee-Temp heater shall be 150W, shall include an integral thermostat to maintain refrigerant temperature at a minimum of 85°F (29°C) and shall require a separate power supply of (208/230V-1ph-60Hz) (120V-1ph-60Hz).
- .6 Low Temp Kit shall function with the condensers variable speed fan motors and electronic controls that lower fan speed in lower outdoor ambient temperatures for maximum energy efficiency. This system shall allow system startup and positive head pressure control with ambient temperatures as low as -30°F (-34.4°C).
- .7 Receiver Kit shall contain a painted, un-insulated receiver with integral fusible plug, formed copper pipe for ease of connecting condenser liquid line to receiver and mounting bracket. Additional full-length leg is shipped with condenser (18 in., 36 in. and 48 in.) or with 60 in. leg kit and should be secured to the mounting surface. One receiver kit shall be field installed per refrigerant circuit.

- .15 REFRIGERANT PIPING, VALVES, FITTINGS AND ACCESSORIES WITHIN UNIT
 - .1 To CSA B52.
 - .2 Include for each refrigerant circuit:
 - .1 Thermal expansion valve, external equalizing type.
 - .2 Combination filter-dryer.
 - .3 Solenoid valves.
 - .4 Liquid sight glass with moisture indicator.
 - .5 Suction line insulation: flexible elastomeric unicellar to ASTM C547, 12 mm minimum thickness.
- .16 CONTROLS
 - .1 Solid state electronic control system.
 - .2 Front mounted operating panel with visual display for floor mount units. Wall mounted operating panel with visual display for ceiling mounted units.
 - .3 System to include following:
 - .1 Manual operation and adjustment:
 - .1 On-Off air conditioning system control.
 - .2 Room temperature set point, indicator and sensitivity adjustment controller.
 - .3 Room humidity set point, indicator and sensitivity adjustment controller.
 - .4 Alarm silencing switch for each alarm point.
 - .5 Alarm circuits test switch.
 - .2 Operational: Visual and Audible Alarm:
 - .1 Loss of air flow.
 - .2 Loss of glycol flow
 - .3 High room temperature.
 - .4 Low room temperature.
 - .5 High humidity.
 - .6 Low humidity.
 - .7 High head pressure.
 - .3 Operational: Visual Display:
 - .1 Cooling.
 - .2 Humidification
 - .3 Dehumidification.
 - .4 Change filter.
 - .4 Leak Detection Module
 - .1 Single point leak detection with local alarm and alarm to building automation system.
 - .5 Duplex application:
 - .1 Provide manufacturer supplied auto-changeover control panel for lead-lag, emergency switch over, and staged control of units. Interlock respective motorized supply air damper with unit operation.
 - .6 ModBus/BACnet

- .1 Micro-processor based module for two-way communication between building automation systems and CRAC units.
 - .2 Equipment shall be BACnet compliant and integrate with existing BMS.
- .17 REFRIGERANT CHARGE
- .1 Charge refrigerant system at factory, seal and test.
 - .2 Holding charge of refrigerant applied at factory.

PART 3 EXECUTION

3.1 General

- .1 Install as indicated, to manufacturer's recommendations, and in accordance with EPS 1/RA/2.
- .2 Manufacturer to certify installation.
- .3 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.
- .4 Install condensing units at grade with manufactured raised stand consisting of recycled rubber blocks and extruded galvanized structural channels.
- .5 Support all exterior piping at grade with recycled rubber blocks with integral extruded channels and manufactured piped clamps.

3.2 Equipment Preparation

- .1 Provide services of manufacturer's field engineer to set and adjust equipment for operation as specified.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Material and installation of split type room air conditioning system, including indoor evaporator unit and outdoor condensing unit.
- .2 Related Sections:
 - .1 Everything in this Project Manual is a requirement for this Division.

1.2 References

- .1 Canadian Standards Association (CSA International)
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .2 Environment Canada, (EC)/Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 In addition to the requirements specified elsewhere, include the following additional information:
 - .1 Indicate major components and accessories including sound power levels of units.
 - .2 Type of refrigerant used, R-410A.

1.4 Warranty

- .1 Provide 5 year warranty including material and labour on compressors.

1.5 Closeout Submittals

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

PART 2 PRODUCTS

2.1 General

- .1 The system will utilize an air cooled condensing unit supplying a matching indoor unit, with year round cooling capability.

2.2 Split Air Conditioning Systems:

- .1 Section applies to: call centre systems and server room

.2 INDOOR AIR CONDITIONING UNITS

.1 Above Ceiling Ducted Units

- .1 The units will be manufactured from galvanized steel plate partially insulated with closed cell expanded polyurethane foam.
- .2 Air will be discharged by a forward curved centrifugal fan horizontally out of the front of the unit to allow for field supply ductwork and diffusers to distribute the air into the room. Return air will be brought in through the rear of the unit to allow for the return air to be either ducted from the room or taken from the ceiling void.
- .3 A synthetic fiber washable filter and filter casement shall be provided as for all units.

.2 Wall Mounted Unit

- .1 The unit will be manufactured from ABS plastic.
- .2 Air will be discharged by a tangential line flow fan through an outlet in the bottom front edge of the unit. The outlet will have electronically adjustable vanes to enable variable air discharge through the horizontal to vertical downward planes. The outlet shall also include manually adjustable guide vanes to alter the airflow pattern in the horizontal directional plane.
- .3 Air will be returned to the unit through grilles mounted in the front face of the unit above the outlet. The return air will be filtered by synthetic fibre washable filters mounted behind the return air grilles.

.3 OUTDOOR CONDENSING UNITS

.1 Condensing Units

- .1 Condensing unit shall be capable of low ambient (-40 C) operation
- .2 The indoor units must be of the same capacity as the outdoor unit.
- .3 The outdoor unit will be constructed from steel plate and painted with acrylic paint.
- .4 The fan grille shall be of polypropylene (PP) plastic.
- .5 The unit shall be furnished with DC fan motors for direct drive propeller fan.
- .6 The motor bearings shall be permanently lubricated
- .7 The fan shall be mounted in front of the coil, pulling air across it from the rear and discharging it through the front.
- .8 The L shaped condenser coil shall be of copper tubing with flat aluminum fins.
- .9 The coil shall be protected with an integral metal guard.

- .10 The compressor shall be hermetic rotary type with variable compressor speed inverter technology
- .11 The compressor crankcase shall be heated by intermittent low speed compressor motor rotation.
- .12 The outdoor unit shall have high pressure and over current protective device.
- .13 The unit electrical power shall be 208/230 Vac, 1 phase, 60 hertz.
- .14 The unit shall operate within voltage limits of 198Vac to 253Vac.
- .15 The unit shall have a power factor of 98%.

.4 CONTROLS

- .1 Reduced Function Zone Controller
 - .1 This controller shall be wall mounted and hard wired to the indoor fan coil units. It will be manufactured in ABS plastic with an LCD display and will be the manufacturer's standard colour.
 - .2 The controller will be capable of switching on/off and altering the set point and mode of up to sixteen indoor fan coil units. The controller will also display unit fault codes.
 - .3 Provide one per indoor unit.
- .2 Centralized Controller: The controller shall be capable of displaying the following information individually for fifty indoor fan coil units:
 - .1 on/off.
 - .2 operating mode.
 - .3 set point.
 - .4 fan speed.
 - .5 louvre position.
 - .6 timer settings.
 - .7 test run.
 - .8 fault diagnosis.

.5 BMS Control

- .1 The entire systems shall interface with the BMS via BACnet interface module through the centralized controller. Controlled variables will be ON/OFF, mode operation, set point adjustment, fan speed.
- .2 Monitoring will be ON/OFF mode operation, temperature set point, fan speed, return air temperature and fault code.

PART 3 EXECUTION

3.1 General

- .1 Manufacturer to certify installation.
- .2 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain with copper piping. Condensate piping shall not be exposed in finished areas. Where condensate cannot drain by gravity, provide condensate lift pump.
- .3 Install air conditioning system in accordance with manufacturer's installation instructions.

- .4 Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- .5 The fixing of all air conditioning equipment, installation of all refrigerant pipe work and full commissioning shall be performed by a specialist refrigerant installer who shall be authorized to install manufacturer's equipment. The installation of all internal and external units, refrigerant pipe work, inter-connecting wiring, commissioning and testing shall be carried out by an approved refrigerant systems installers.
- .6 Full access shall be afforded to site during the installations stage of the project to allow them to verify that installation methods are fully in accordance with manufacturers requirements and that the equipment warranties will not be invalidated.

3.2 Electrical Wiring

- .1 Install electrical devices furnished by manufacturer but not specified to be factory mounted, in accordance with requirements of Division 26.
- .2 Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

3.3 Refrigerant Piping

- .1 Supply, install, test and commission all interconnecting refrigeration pipe work between the outdoor and indoor units.
- .2 All pipe work to be carried out in refrigerant quality ACR copper tubing and complete with the appropriate headers and joints. All pipe work must be suitable for R410A.
- .3 Longest possible lengths of copper pipe should be utilized to minimize joints on site.
- .4 Appropriate refrigeration installation tools must be utilized. Dry Nitrogen must be utilized at all times in the system during brazing.
- .5 All pipe work (suction and liquid lines) to be insulated with slip on close cell elastomeric pipe insulation having a wall thickness of not less than 1/2".
- .6 After installation of pipe work, and prior to sealing of insulation joints and starting of equipment, pipe work should be pressure tested. 303 kPa (44 PSI) test for 3 minutes minimum, then 1500 kPa (217 PSI) for 3 minimum, then 3300 kPa (478 PSI) for 3 minutes minimum, then strength test to 4140 kPa (600 PSI) check the system for leaks and deformation, then lower the pressure back to 3300 kPa (478 PSI) and pressure test for 24 hours and checked for leaks. Vacuumed/dehydrated to 300 microns, and hold at that vacuum for 12 hours (minimum).
- .7 Refrigerant (R410A) charge weight must be calculated, to the actual installed length of pipe work in accordance to manufacturer's recommendations.
- .8 The charging should be carried out with an appropriate charging station.
- .9 Pipe work to be properly fixed and supported at a minimum of 1.5 metres (5 feet) centres or as specified by local code and where required should be run on galvanized trays. All pipe work to be labeled with ID number (condensing units ref.) at 3 metre (9 feet) intervals.

- .10 Joints in copper pipe shall be brazed. Brazing shall be carried out to the requirements of the local code and as per the Canadian copper & brass development association recommendations.
- .11 Support all equipment on roof on manufactured non-penetrating support system with rubber bases and unistrut members.
- .12 Refer also to 23 23 00.

3.4 Piping Connections

- .1 Install and connect devices furnished by manufacturer but not specified to be factory mounted.
- .2 Connect condensate drain to the air conditioning unit and drain indirectly to nearest janitors room or washroom floor drain. Pitch and trap drain in accordance with manufacturer's instructions and prevailing codes/regulations. Provide condensate pump if flow by gravity is not possible. Piping to be soldered copper tube, hard drawn temper, type L.
- .3 Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

3.5 Line Set Covers

- .1 Install all exposed, and surface mounted piping/wiring in line set covers.
- .2 Provide line set covers for all exposed interior piping. Install piping and condensate tight to walls and ceilings inside line set covers. System to be constructed of paintable PVC with integral zip tie system for securing piping and wiring. Provide molded PVC fittings as required to offset around architectural elements (columns, beams, etc) and for penetrations. Two-part system with base and cover.

3.6 Controls

- .1 Install control devices furnished by manufacturer but not specified to be factory mounted.
- .2 Furnish copy of manufacturer's controls connection diagram submittal to the electrical contractor.
- .3 All control wiring to be run in conduit.
- .4 Provide services of manufacturer's field Departmental Representative to set and adjust equipment for operation as specified.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Institute of Boiler and Radiator Manufacturers (IBR)
- .2 US Department of Commerce
 - .1 CS 140-47, Commercial Standard.

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 finned tube radiation heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Equipment, capacity, piping, and connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
 - .3 Special enclosures.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 finned tube radiation heaters 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.
- .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 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 related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

PART 2 PRODUCTS

2.1 Dampers

- .1 Factory built, internal damper, at enclosure air outlet grille for each convection type heating unit not thermostatically controlled. Refer to schedules on drawings.

2.2 Capacity

- .1 As indicated, based on 93 degrees C average water temperature, 11 degrees C temperature drop and 18 degrees C at entering air temperature.

2.3 Finned Tube Radiation

- .1 Heating elements: NPS 1 seamless copper tubing, 1.2 mm minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 100 x 100 mm nominal, 130 fins per metre suitable for sweat fittings.
- .2 Element hangers: ball bearings cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm centres maximum.
- .3 Standard enclosures: 1.6 mm thick steel complete with components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Provide access doors for valves, vents, controls, and accessories. Finish cabinet with factory applied baked primer coat.
- .4 Special enclosures: as indicated.
- .5 Dimensions for enclosures: measure site conditions. Do not scale from drawing.
- .6 Provide for noiseless expansion of components.
- .7 Expansion compensators.

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.
 - .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 in accordance with piping layout and reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.

- .5 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .6 Valves:
 - .1 Install valves with stems upright or horizontal unless approved otherwise.
 - .2 Install isolating [gate] valves on inlet and lockshield globe balancing valves on outlet of each unit.
- .7 Venting:
 - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
 - .2 Install automatic air vent on continuous finned tube radiation.
- .8 Clean finned tubes and comb straight.
- .9 Install flexible expansion compensators as indicated.

3.3 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 Waste Management: separate waste materials for reuse and recycling.
 - .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 Section Includes:
 - .1 The supply and installation of humidifiers and related accessories.

1.2 References

- .1 Canadian Standards Association (CSA)
- .2 Underwriters Laboratories of Canada (ULC)

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate following: voltage, total power, steam output.

1.4 Closeout Submittals

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

1.5 Extra Materials

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.

1.6 Manufactured Items

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

PART 2 PRODUCTS

2.1 Packaged Steam Exchange Humidifier.

- .1 CSA certified and ULC listed.
- .2 Method of distribution shall be through a short absorption manifold mounted in section of air handling unit or in supply air ductwork as per drawings.
- .3 Provide electrode humidifier generating mineral-free, sterile steam from a potable water supply Packaged unit, wall mounted, atmospheric steam generation using an electrode steam cylinder. Resistive element technology and boiler steam (pressure steam) technology not acceptable.
- .4 Units to be complete with:
 - .1 Touchscreen controller with standard building automation:
 - .1 Intuitive touchscreen control with color graphic user interface.
 - .2 Standard building automation communication protocols BACnet IP, BACnet MSTP (Slave) and Modbus. Additional hardware required for building automation communication not acceptable.
 - .3 Embedded web interface for easy configuration and remote monitoring from any computer with a web browser over a local area network (LAN) connection.
 - .4 USB interface for new software/feature upload and download of operational information.
 - .5 Single or dual channel analog signal acceptance, supporting both demand and transducer control. Ability to control setpoint from humidifier control when using transducer controls.
 - .2 Packaged system with electrode cylinder technology:
 - .1 Cylinder optimized for humidifier capacity and supply voltage. Cylinder must have welded seam to ensure watertight and have high water sensor to prevent overfilling.
 - .2 Durable powder coated steel cabinet with zero side clearance requirement for minimal footprint.
 - .3 Insulating air gap between plumbing and electrical compartment for increased electronic reliability.
 - .4 Standard internal drain water tempering to ensure maximum 140° F (60° C) drain water. External drain water cooler not acceptable.
 - .5 Integral fill cup with minimum 1-inch (25 mm) air gap to prevent back siphoning.
 - .6 Full cylinder indication and pre-notification of automatic shutdown at end of cylinder life.
 - .7 Automatic pulse feature to clean any obstruction from the drain solenoid valve if required.
 - .8 Automatic off-season shut-down (after 3 days of "no call") will completely drain the cylinder and automatically restart on call for humidity. Adjustable on/off and time sequence. Provides extended cylinder life, while ensuring stagnant water does not remain in the system.

- .3 Auto-Adaptive Control water management:
 - .1 Advanced water management utilizing the patented Proportional plus Integral Auto-Adaptive Control system for optimal energy efficiency, water usage and cylinder life.
 - .2 98% thermal efficiency from startup until end of cylinder life.
 - .3 Drains automatically optimized to water conditions to maximize cylinder and reduce water usage.
 - .4 Modulating output between 20% and 100% of rated capacity.
- .5 Accessories to be provided
 - .1 Steam distribution tube for duct installation
 - .2 Steam distribution hose
 - .3 Remote mounted blower pack for direct room humidification for server room unit
 - .4 Condensate hose
 - .5 Filter valve
 - .6 Remote fault indication board
 - .7 Accessory board
 - .8 Over-pressure kit for installations with duct static pressure greater than 5.5" WC
 - .9 Humidity sensors and humidistats
 - .10 Lon Works-connectivity
 - .11 Enhanced foam detection

PART 3 EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturers instructions.
- .2 Humidifier and evaporator media to be new and clean when project is accepted.
- .3 Install humidistat and air flow proving switch in accessible location.
- .4 Water service overflow drain: to manufacturers' recommendation.
- .5 Install access doors or panels in adjacent ducting.
- .6 When installing in ducting, provide waterproof duct up and downstream.
- .7 Install capped drain connection at low point in duct.

3.2 Start-Up

- .1 General: In accordance with Section 01 91 00 - Commissioning: General Requirements, supplemented as specified herein.
- .2 Verify:

- .1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.
- .2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the duct system.
- .3 Visually check distribution manifold to ensure:
 - .1 Even distribution of vapour.
 - .2 Freedom from water deposits.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Requirements for Halocarbon Management.

1.2 References

- .1 Status of Canada 1999 chapter 33: "Canadian Environmental Protection Act 1999:
 - .1 SOR/2003-289: "Federal Halocarbon Regulations 2003".
- .2 Environmental Code of practice for Eliminations of Fluorocarbon Emissions from Refrigeration and Air conditioning Systems (the Environment Canada " Refrigeration Code of Practice", and the Report EPS 1 RA/2 dated March 1996.

1.3 General

- .1 Contractors and their personnel shall be familiar with the Section and its requirements.
- .2 The Contractor will comply with all Federal, Provincial, and Municipal regulatory requirements and guidelines for environmental protection and natural resources conservation, including the References noted above.
- .3 It is the Contractor's responsibility to be aware of environmental requirements, the best management practices, and pollution control measures necessary to meet them.

1.4 Halocarbons

- .1 All work relating to halocarbons to comply with referenced standards outlined above in Paragraph 1.2 – References.
- .2 All work related to halocarbon equipment installation, servicing, etc., to be carried out by, or under direct supervision of, a technician licensed by the Province where work is taking place as a refrigeration mechanic.
- .3 Technician to provide to Departmental Representative:
 - .1 Copy of Province of Manitoba license.
 - .2 Certificate issued by the Heating, Refrigeration, and Air Conditioning Institute of Canada; and,
 - .3 Ozone Depletion Prevention Substance Awareness Card.
- .4 The following are the only halocarbons that are acceptable as refrigerants: (non-halocarbon refrigerants are also acceptable)
 - .1 R-410a
 - .2 R-407c
- .5 All work related to halocarbon equipment installation, servicing, decommissioning, leak-testing to be documented.

- .6 Immediately report all releases of halocarbons to Departmental Representative.
Document release on Spill Report form.
- .7 Factory-charged halocarbon-containing shall be leak-tested by this Contractor in accordance with the "Refrigeration code of Practice" within one working day after delivery to the site.
 - .1 No payment for delivery of this equipment to the site will be made until it is documented to be leak-free.
- .8 Non-factory-sealed halocarbon-containing equipment shall be leak-tested using "triple evacuation": evacuate the system to 400 micron or less and break the vacuum with dry nitrogen three times.
 - .1 No payment for delivery of this equipment to the site will be made until it is documented to be leak-free.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section Includes.
 - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
 - .1 Start-up testing and verification of systems.
 - .2 Check out demonstration or proper operation of components.
 - .3 On-site operational tests.

1.2 Definitions

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL: ratio between total test periods less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
 - .1 Outage of main power supply in excess of back-up power sources, provided that:
 - .1 Automatic initiation of back-up was accomplished.
 - .2 Automatic shut-down and re-start of components was as specified.
 - .2 Failure of communications link, provided that:
 - .1 Controller automatically and correctly operated in stand-alone mode.
 - .2 Failure was not due to failure of any specified EMCS equipment.
 - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
 - .1 System recorded said fault.
 - .2 Equipment defaulted to fail-safe mode.
 - .3 AEL of total of all input sensors and output devices is at least [99] % during test period.

1.3 Design Requirements

- .1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.4 Action And Informational Submittals

- .1 Submittals in accordance with Section 01330 - Submittal Procedures.
- .2 Final Report: submit report to Departmental Representative.
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor

- .3 Report format to be approved by Departmental Representative before commissioning is started.
- .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
- .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.5 Closeout Submittals

- .1 Provide documentation, O M Manuals, and training of O M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.6 Commissioning

- .1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative.
- .3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
 - .1 Location and part of system to be tested or commissioned.
 - .2 Testing/commissioning procedures, anticipated results.
 - .3 Names of testing/commissioning personnel.
- .4 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 Load system with project software.
- .7 Perform tests as required.

1.7 Completion Of Commissioning

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative.

1.8 Issuance Of Final Certificate Of Completion

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

PART 2 PRODUCTS

2.1 Equipment

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

PART 3 EXECUTION

3.1 Procedures

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by Departmental Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

3.2 Field Quality Control

- .1 Pre-Installation Testing.
 - .1 General: consists of field tests of equipment just prior to installation.
 - .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
 - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
 - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
 - .5 Additional instruments to include:
 - .1 DP transmitters.
 - .2 VAV supply duct SP transmitters.
 - .3 DP switches used for dirty filter indication and fan status.
 - .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source.
 - .7 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.
 - .8 Departmental Representative to mark instruments tracking within % in both directions as "approved for installation".
 - .9 Transmitters above 0.5% error will be rejected.
 - .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.

- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
- .2 Include following activities:
 - .1 Test and calibrate field hardware including stand-alone capability of each controller.
 - .2 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.
 - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
 - .7 Test operating software.
 - .8 Test application software and provide samples of logs and commands.
 - .9 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
 - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative. This document will be used in final startup testing.
- .3 Final Start-up Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and provide:
 - .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
 - .4 Commissioning to commence during final startup testing.
 - .5 O M personnel to assist in commissioning procedures as part of training.
 - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
 - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .8 Operate systems as long as necessary to commission entire project.
 - .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
 - .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

- .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
- .2 Test to last at least 30 consecutive 24 hour days.
- .3 Tests to include:
 - .1 Demonstration of correct operation of monitored and controlled points.
 - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
- .4 System will be accepted when:
 - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
 - .2 Requirements of Contract have been met.
- .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
- .6 Correct defects when they occur and before resuming tests.
- .5 Departmental Representative to verify reported results.

3.3 Adjusting

- .1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

3.4 Demonstration

- .1 Demonstrate to Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section Includes.
 - .1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.2 Definitions

- .1 CDL - Control Description Logic.
- .2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
 - .1 List name of trainer, and type of visual and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.4 Quality Assurance

- .1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Departmental Representative reserves right to approve instructors.

1.5 Instructions

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.

1.6 Time For Training

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.7 Training Materials

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.

- .1 Review contents of manual in detail to explain aspects of operation and maintenance (O M).

1.8 Training Program

- .1 To be in 2 phases over 6 month period.
- .2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative.
 - .1 Train O M personnel in functional operations and procedures to be employed for system operation.
 - .2 Supplement with on-the-job training during 30 day test period.
 - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
 - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: 5 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.
 - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
 - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
 - .2 Equipment maintenance training: provide personnel with 2 days training within 5 day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
 - .3 Programmers: provide personnel with 2 days training within 5 day period in following subjects in approximate percentages of total course shown:

Software and architecture: 10%
Application programs: 15%
Controller programming: 50%
Trouble shooting and debugging:10%
Colour graphic generation: 15%

1.9 Additional Training

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.10 Monitoring Of Training

- .1 Departmental Representative to monitor training program and may modify schedule and content.

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 for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

1.2 References

- .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 International).
 - .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 (Jus).
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Electrical and Electronic Manufacturers Association (EEMAC).
 - .1 EEMAC 2Y-1, Light Gray 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.

1.3 Acronyms And Abbreviations

- .1 Acronyms used in EMCS:
 - .1 AEL - Average Effectiveness Level.
 - .2 AI - Analog Input.
 - .3 AIT - Agreement on International Trade.
 - .4 AO - Analog Output.

- .5 BACnet - Building Automation and Control Network.
- .6 BC(s) - Building Controller(s).
- .7 BECC - Building Environmental Control Center.
- .8 CAD - Computer Aided Design.
- .9 CDL - Control Description Logic.
- .10 CDS - Control Design Schematic.
- .11 COSV - Change of State or Value.
- .12 CPU - Central Processing Unit.
- .13 DI - Digital Input.
- .14 DO - Digital Output.
- .15 DP - Differential Pressure.
- .16 ECU - Equipment Control Unit.
- .17 EMCS - Energy Monitoring and Control System.
- .18 HVAC - Heating, Ventilation, Air Conditioning.
- .19 IDE - Interface Device Equipment.
- .20 I/O - Input/Output.
- .21 ISA - Industry Standard Architecture.
- .22 LAN - Local Area Network.
- .23 LCU - Local Control Unit.
- .24 MCU - Master Control Unit.
- .25 NAFTA - North American Free Trade Agreement.
- .26 NC - Normally Closed.
- .27 NO - Normally Open.
- .28 OS - Operating System.
- .29 O M - Operation and Maintenance.
- .30 OWS - Operator Work Station.
- .31 PC - Personal Computer.
- .32 PCI - Peripheral Control Interface.
- .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .34 PID - Proportional, Integral and Derivative.
- .35 RAM - Random Access Memory.
- .36 SP - Static Pressure.
- .37 ROM - Read Only Memory.
- .38 TCU - Terminal Control Unit.
- .39 USB - Universal Serial Bus.
- .40 UPS - Uninterruptible Power Supply.
- .41 VAV - Variable Air Volume.

1.4 Definitions

- .1 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

- .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
 - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide [25] character field for each point identifier. "System" is system that point is located on.
 - .1 Area descriptor: building or part of building where point is located.
 - .2 System descriptor: system that point is located on.
 - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be short forms or acronyms. Database must provide 25 character field for each point identifier.
 - .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of 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.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.
 - .2 Refer also to Section 25 05 54- EMCS: Identification.

1.5 System Description

- .1 Refer to control schematics.
- .2 Provide DDC equipment for control of new HVAC equipment, to match existing and integrate with existing on-site control system and connect directly to the existing network(s) and existing web-server operator interface software.
- .3 Include complete system of hardware and software as manufactured by the existing controls system manufacturer already in the building. Components and interconnecting systems to be installed by trained technicians, regularly employed in the Controls industry.
- .4 Data communication network to link Systems Controllers, Application Controllers and network devices together and to the existing Operators Interface Web-Server application.
 - .1 The intent is to provide a complete working system for control of new equipment which interfaces and connects to the existing building DDC system.

- .5 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 Data communications equipment necessary to effect EMCS data transmission system.
 - .4 Field control devices.
 - .5 Software/Hardware complete with full documentation.
 - .6 Complete operating and maintenance manuals.
 - .7 Training of personnel.
 - .8 Acceptance tests, technical support during commissioning, full documentation.
 - .9 Wiring interface co-ordination of equipment supplied by others.
 - .10 Miscellaneous work as specified in these sections and as indicated.
- .6 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 devices.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.

1.6 Action And Informational Submittals

- .1 Make submittals in accordance with 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
- .2 Submit for review:
 - .1 Equipment list, systems manufacturers, at time of bid.
 - .2 List existing field control devices to be re-used included in bid, along with unit price.
- .3 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
 - .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
 - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own

listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

- .6 Permits and fees: in accordance with general conditions of contract.
- .7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.
- .8 Existing devices intended for re-use: submit test report.

1.7 Quality Assurance

- .1 Match existing controls equipment and provide equipment from same manufacturer and vendor. Installer shall have experience and shall have performed work in the building, facility or campus within the past 2 yrs.
- .2 Have local office within 50 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .3 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .4 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .5 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.8 Delivery, Storage And Handling

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

1.9 Existing- Control Components

- .1 Allow for new wiring. Utilize existing control wiring and piping is acceptable if existing wiring meets specifications and is installed in conduit.
- .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.
- .3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to any work taking place in the space.
 - .1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.
 - .2 Failure to produce test report will constitute acceptance of existing devices by contractor.
- .4 Non-functioning items:
 - .1 Provide with report specification sheets or written functional requirements to support findings.
 - .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.

- .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
 - .1 Be responsible for items repaired or replaced by Departmental Representative.
 - .2 Be responsible for repair costs due to negligence or abuse of equipment.
 - .3 Responsibility for existing devices terminates upon final acceptance of EMCS.
- .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

PART 2 PRODUCTS

2.1 Equipment

- .1 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.

2.2 Adaptors

- .1 Provide adaptors between metric and imperial components.

PART 3 EXECUTION

3.1 Manufacturer's Recommendations

- .1 Installation: to manufacturer's recommendations.

3.2 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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.3 Painting

- .1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:
 - .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
 - .2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
 - .3 Clean and prime exposed hangers, racks, fastenings, and other support components.
 - .4 Paint unfinished equipment installed indoors.

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 Waste Management: separate waste materials for reuse and recycling.
 - .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 Section Includes.
 - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

1.2 Definitions

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

1.3 Design Requirements

- .1 Preliminary Design Review: to contain following contractor and systems information.
 - .1 Location of local office.
 - .2 Description and location of installing and servicing technical staff.
 - .3 Location and qualifications of programming design and programming support staff.
 - .4 List of spare parts.
 - .5 Location of spare parts stock.
 - .6 Names of sub-contractors and site-specific key personnel.
 - .7 Sketch of site-specific system architecture.
 - .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
 - .9 Descriptive brochures.
 - .10 Sample CDL and graphics (systems schematics).
 - .11 Response time for each type of command and report.
 - .12 Item-by-item statement of compliance.
 - .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

1.4 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by Departmental Representative.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.
- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.5 Preliminary Shop Drawing Review

- .1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
 - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
 - .2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.
 - .3 Spare point capacity of each controller by number and type.
 - .4 Controller locations.
 - .5 Auxiliary control cabinet locations.
 - .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
 - .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
 - .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

1.6 Detailed Shop Drawing Review

- .1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
 - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
 - .2 Wiring diagrams.
 - .3 Piping diagrams and hook-ups.
 - .4 Interface wiring diagrams showing termination connections and signal levels.
 - .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
 - .1 Sensing element type and location.
 - .2 Transmitter type and range.
 - .3 Associated field wiring schematics, schedules and terminations.
 - .4 Complete Point Name Lists.
 - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
 - .6 Software and programming details associated with each point.
 - .7 Manufacturer's recommended installation instructions and procedures.
 - .8 Input and output signal levels or pressures where new system ties into existing control equipment.
 - .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

- .7 Graphic system schematic displays of systems with point identifiers and textual description of system, and typical floor plans as specified.
- .8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
- .9 Listing and example of specified reports.
- .10 Listing of time of day schedules.
- .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
- .12 Type and size of memory with statement of spare memory capacity.
- .13 Full description of software programs provided.
- .14 Sample of "Operating Instructions Manual" to be used for training purposes.
- .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.7 Quality Assurance

- .1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:
 - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
 - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
 - .3 Review interface requirements of materials supplied by others.
 - .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not Used.

PART 3 EXECUTION

3.1 Not Used

- .1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section Includes.
 - .1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 Definitions

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 For additional acryonyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.
- .2 Submit Record Documents to Departmental Representative in English.
- .3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
 - .1 Binders to be 2/3 maximum full.
 - .2 Provide index to full volume in each binder.
 - .3 Identify contents of each manual on cover and spine.
 - .4 Provide Table of Contents in each manual.
 - .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 As-Builts

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
 - .1 Changes to contract documents as well as addenda and contract extras.
 - .2 Changes to interface wiring.
 - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
 - .4 Locations of obscure devices to be indicated on drawings.
 - .5 Listing of alarm messages.
 - .6 Panel/circuit breaker number for sources of normal/emergency power.
 - .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
 - .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
 - .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.

- .3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

1.5 O&M Manuals

- .1 Custom design O M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests
- .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .4 Functional description to include:
 - .1 Functional description of theory of operation.
 - .2 Design philosophy.
 - .3 Specific functions of design philosophy and system.
 - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
 - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
 - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented [or planned] for implementation in automatic mode.
- .5 System operation to include:
 - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
 - .2 Operation of computer peripherals, input and output formats.
 - .3 Emergency, alarm and failure recovery.
 - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .6 Software to include:
 - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
 - .2 Detailed descriptions of program requirements and capabilities.
 - .3 Data necessary to permit modification, relocation, reprogramming and to permit [new and existing]software modules to respond to changing system functional requirements without disrupting normal operation.
 - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
 - .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

- .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
 - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
 - .2 Information to ensure 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.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not Used.

PART 3 EXECUTION

3.1 Not Used

- .1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 References

- .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 CSA Group
 - .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 power wiring to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
 - .2 Hard wiring between field control devices and EMCS field panels.
 - .3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
 - .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .5 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 EMCS Contractor.
 - .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by EMCS Contractor.
 - .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.
- .3 VAV Terminal Units.
 - .1 Air flow probe for VAV boxes to be supplied and installed under Section 23 36 00 - Air Terminal Units, clause. Air flow DP sensor, actuator and associated VAV controls to be supplied and installed by EMCS contractor. Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and

actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.

- .4 Structural:
 - .1 Special steelwork as required for installation of work.

1.3 Personnel Qualifications

- .1 Qualified supervisory personnel to:
 - .1 Continuously direct and monitor all work.
 - .2 Attend site meetings.

1.4 Existing Conditions

- .1 Cutting and Patching: refer to Section 01 73 00 - Execution supplemented as specified herein.
- .2 Repair all surfaces damaged during execution of work.
- .3 Turn over to Departmental Representative existing materials removed from work not identified for re-use.

PART 2 PRODUCTS

2.1 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: 20 AWG stranded twisted pair, minimum.
 - .4 Analog input and output: shielded #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.

2.2 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.

2.3 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.

2.4 Starters, Control Devices

- .1 Across-the-line magnetic starters:
 - .1 Enclosures: CSA Type 1, except where otherwise specified.
 - .2 Size, type and rating: to suit motors.
- .2 Starter diagrams:
 - .1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.
- .3 Auxiliary Control Devices:
 - .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
 - .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
 - .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
 - .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.
- .4 Finish for starters:

- .1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Interior: white.

2.5 Supports For Conduit, Fastenings, Equipment

- .1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
 - .1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.
- .2 Exposed conduits or cables:
 - .1 50 mm diameter and smaller: one-hole steel straps.
 - .2 Larger than 50 mm diameter: two-hole steel straps.
- .3 Suspended support systems:
 - .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
 - .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 EXECUTION

3.1 Installation

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 Mechanical Piping

- .1 Install piping straight, parallel and close to building structure with required grades for drainage and venting.
- .2 Ream ends of pipes before assembly.
- .3 Copper tubing not to come into contact with dissimilar metal.
- .4 Use non-corrosive lubricant or Teflon tape on male screwed threads.
- .5 Clean ends of pipes, tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .6 Install di-electric couplings where dissimilar metals joined.
- .7 Sleeves:
 - .1 Installation:
 - .1 Concrete, masonry walls, and concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint.
 - .2 Caulking:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: provide space for fire stopping by Section [07 84 00 – Fire Stopping]. Maintain fire rating integrity.

- .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
- .4 Ensure no contact between copper pipe or tube and sleeve.
- .8 Pressure tests:
 - .1 Pressure test all piping systems modified under this contract to 1 1/2 times maximum working pressure or 860 kPa (whichever is greater) for 4 hours without loss of pressure. Isolate equipment, components, not designed to withstand test pressure.
- .9 Introduce system pressure carefully into new piping.

3.3 Electrical General

- .1 Do complete installation in accordance with requirements of:
 - .1 Division 26, this specification.
 - .2 CSA 22.1 Canadian Electrical Code.
 - .3 ANSI/NFPA 70.
 - .4 ANSI C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage (above 70 V) contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 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 Departmental Representative before starting such work. Provide complete conduit system to link field panels and

- devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.
- .4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
 - .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
 - .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
 - .7 Limit conduit length between pull boxes to less than 30 m.
 - .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
 - .9 Fastenings and supports for conduits, cables, and equipment:
 - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
 - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
 - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
 - .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 Departmental Representative'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 in cabinets.
 - .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 Departmental Representative 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 Departmental Representative and authority having jurisdiction.
- .4 Conceal work only after tests satisfactorily completed.
- .5 Report results of tests to Departmental Representative 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 Departmental Representative and authority having jurisdiction.

3.10 Identification

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

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section Includes.
 - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).
- .2 References.
 - .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
 - .2 Canadian Standards Association (CSA International).
 - .1 CSA Z204, Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 Definitions

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
 - .1 Point name and location.
 - .2 Device type and range.
 - .3 Measured value.
 - .4 System displayed value.
 - .5 Calibration detail
 - .6 Indication if adjustment required,
 - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Maintain records and logs of each maintenance task on site.
 - .2 Organize cumulative records for each major component and for entire EMCS chronologically.
 - .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 Maintenance Service During Warranty Period

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
 - .1 Initiate service calls when EMCS is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
 - .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
 - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
 - .1 Serial number identifying component involved.
 - .2 Location, date and time call received.
 - .3 Nature of trouble.
 - .4 Names of personnel assigned.
 - .5 Instructions of work to be done.
 - .6 Amount and nature of materials used.
 - .7 Time and date work started.
 - .8 Time and date of completion.
- .5 Provide system modifications in writing.
 - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.
 - .2 Complete inventory of installed system.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not Used.

PART 3 EXECUTION

3.1 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 Calibrate each field input/output device in accordance CSA Z204.
 - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
 - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
 - .2 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.
- .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 Summary

.1 Section Includes:

- .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

1.2 References

.1 Canadian Standards Association (CSA International).

- .1 CSA T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
- .2 CSA T530, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.

- .1 IEEE Std 802.3TM-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)

- .1 TIA/EIA-568, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
- .2 TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

- .1 TBITS 6.9, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 Definitions

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

1.4 System Description

.1 Data communication network to link Operator Workstations and Master Control Units (MCU).

- .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
- .2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

- .1 EMCS-LAN.
- .2 Modems.
- .3 Network interface cards.

- .4 Network management hardware and software.
- .5 Network components necessary for complete network.

1.5 Design Requirements

- .1 EMCS Local Area Network (EMCS-LAN).
 - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
 - .2 EMCS-LAN to: BACnet Protocol.
 - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
 - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
 - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
 - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
 - .7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
 - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
 - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
 - .1 Network medium: shielded twisted cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

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 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.

1.2 Definitions

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.
- .2 Secondary OWS: serves as backup to primary OWS, is storage and retrieval facility of soft copy of as-built contractor supplied data as described in Section 25 05 03 - EMCS: Project Record Documents.
- .3 Portable OWS: used as remote dial-up OWS with same capabilities as primary OWS including graphic display.
- .4 Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

1.3 Ows System Description

- .1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.

1.4 Action And Informational Submittals

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

1.5 Environmental Conditions

- .1 OWS to operate in conditions of 10 degrees C to 32 degrees C and 20 % to 90 % non-condensing RH.

1.6 Maintenance

- .1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

PART 2 PRODUCTS

2.1 Ows Hardware

- .1 Operator work station is existing.

2.2 Ows Control Software

- .1 Integrate all new systems to existing OWS controls software.
- .2 Update all graphics.

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PART 3 NOT USED

END OF SECTION

PART 1 GENERAL

1.1 Summary

.1 Section Includes:

- .1 Materials and installation for building automation controllers including:
 - .1 Master Control Unit (MCU).
 - .2 Local Control Unit (LCU).
 - .3 Equipment Control Unit (ECU).
 - .4 Terminal Control Unit (TCU).

1.2 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE 2003, Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA International).
 - .1 C22.2 No.205, Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE C37.90.1, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/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>

1.3 Definitions

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

1.4 Description

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
 - .1 Provide sufficient controllers to meet intents and requirements of this section.
 - .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.
 - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
 - .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
 - .3 Capable of interfacing with operator interface device.
 - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need

to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

- .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
- .3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.
 - .1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.
 - .2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

1.5 Design Requirements

- .1 To include:
 - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
 - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
 - .4 Control of systems as described in sequence of operations.
 - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
 - .1 To: CSA C22.2 No.205.
 - .2 Electronically interface sensors and control devices to processor unit.
 - .3 Include, but not be limited to, following:
 - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
 - .2 Power supplies for operation of logics devices and associated field equipment.
 - .3 Lockable wall cabinet.
 - .4 Required communications equipment and wiring (if remote units).
 - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
 - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
 - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
 - .4 AI interface equipment to:
 - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
 - .2 Provide for following input signal types and ranges:
 - .1 4 - 20 mA;
 - .2 0 - 10 V DC;
 - .3 100/1000 ohm RTD input;

- .3 Meet IEEE C37.90.1 surge withstand capability.
- .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
- .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
 - .1 Convert digital data from controller processor to acceptable analog output signals using [8]bit digital-to-analog resolution.
 - .2 Provide for following output signal types and ranges:
 - .1 4 - 20 mA.
 - .2 0 - 10 V DC.
 - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
 - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
 - .2 Meet IEEE C37.90.1 surge withstand capability.
 - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment:
 - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
 - .2 Switch up to 5 amps at 220 V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
 - .1 Provide for conduit entrance from top, bottom or sides of panel.
 - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
 - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 Action And Informational Submittals

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
 - .1 Submit product data sheets for each product item proposed for this project.

1.7 Maintenance

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

PART 2 PRODUCTS

2.1 Master Control Unit (Mcu)

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
 - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
 - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
 - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
 - .1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
 - .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
 - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
 - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
 - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
 - .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.
- .5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.
 - .1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.
 - .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
 - .3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.
 - .4 Functions to include, but not be limited to, following:
 - .1 Start and stop points.
 - .2 Modify setpoints.
 - .3 Modify PID loop parameters.

- .4 Override PID control.
- .5 Change time/date.
- .6 Add/modify/start/stop weekly scheduling.
- .7 Add/modify setpoint weekly scheduling.
- .8 Enter temporary override schedules.
- .9 Define holiday schedules.
- .10 View analog limits.
- .11 Enter/modify analog warning limits.
- .12 Enter/modify analog alarm limits.
- .13 Enter/modify analog differentials.
- .5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.
- .6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.
- .7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
- .8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 Local Control Unit (Lcu)

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
 - .1 Include minimum 2 interface ports for connection of local computer terminal.
 - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
 - .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
 - .4 Include power supplies for operation of LCU and associated field equipment.
 - .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
 - .6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 Terminal/Equipment Control Unit (Tcu/Ecu)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.

- .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 VAV Terminal Controller.
 - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
 - .2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.
 - .3 Controller to operate independent of network in case of communication failure.
 - .4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 Software

- .1 General.
 - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
 - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
 - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.
 - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
 - .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
 - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
 - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.
- .4 Operator Terminal interface.
 - .1 Operating and control functions include:
 - .1 Multi-level password access protection to allow user/manager to limit workstation control.
 - .2 Alarm management: processing and messages.
 - .3 Operator commands.
 - .4 Reports.
 - .5 Displays.
 - .6 Point identification.

- .5 Pseudo or calculated points.
 - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
 - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .6 Control Description Logic (CDL):
 - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
 - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
 - .3 Perform changes to CDL on-line.
 - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
 - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
 - .6 MCU to be able to perform following pre-tested control algorithms:
 - .1 Two position control.
 - .2 Proportional Integral and Derivative (PID) control.
 - .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
 - .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
 - .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

- .8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
 - .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
 - .1 Time of day scheduling.
 - .2 Calendar based scheduling.
 - .3 Holiday scheduling.
 - .4 Temporary schedule overrides.
 - .5 Optimal start stop.
 - .6 Night setback control.
 - .7 Enthalpy (economizer) switchover.
 - .8 Peak demand limiting.
 - .9 Temperature compensated load rolling.
 - .10 Fan speed/flow rate control.
 - .11 Cold deck reset.
 - .12 Hot deck reset.
 - .13 Hot water reset.
 - .14 Chilled water reset.
 - .15 Condenser water reset.
 - .16 Chiller sequencing.
 - .17 Night purge.
 - .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
 - .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
 - .1 MCUs to accumulate and store automatically run-time for binary input and output points.
 - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
 - .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
 - .4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.
 - .5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWh, litres, tonnes, etc.).
 - .6 Store event totalization records with minimum of 9,999,999 events before reset.
 - .7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 Levels Of Address

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

- .1 Display analog values digitally to [1] place of decimals with negative sign as required.
- .2 Update displayed analog values and status when new values received.
- .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
- .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 Point Name Support

- .1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

PART 3 EXECUTION

3.1 Location

- .1 Location of Controllers to be approved by Departmental Representative.

3.2 Installation

- .1 Install Controllers in secure locking enclosures.
- .2 Provide necessary power from local 120V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

PART 1 GENERAL

1.1 Summary

.1 Section Includes:

- .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, low voltage current transformers.

1.2 References

.1 American National Standards Institute (ANSI).

- .1 ANSI C12.7, Requirements for Watthour 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 International).

- .1 CSA-C22.1, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.3 Definitions

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

1.4 Action And Informational Submittals

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.

- .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:

- .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.5 Existing Conditions

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.

- .3 Turn over to Departmental Representative existing materials removed from Work not identified for re-use.

PART 2 PRODUCTS

2.1 General

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant.
- .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: Site Requirements, Applications and System Sequences of Operation.

2.2 Temperature Sensors

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
 - .1 Thermocouples: limit to temperature range of 200 degrees C and over.
 - .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
 - .3 Sensing element: hermetically sealed.
 - .4 Stem and tip construction: copper or type 304 stainless steel.
 - .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
 - .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm.
- .2 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint [and occupied/unoccupied mode].
 - .3 Jack connection for plugging in laptop personal computer 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.
- .2 Room temperature sensors:
 - .1 Wall mounting, in slotted type covers having brushed aluminum finish
 - .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 Duct temperature sensors:
 - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.
 - .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 Humidity Sensors

- .1 Room and Duct Requirements:

- .1 Range: 5 - 90 % RH minimum.
- .2 Operating temperature range: 0 - 60 degrees C.
- .3 Absolute accuracy:
 - .1 Duct sensors: plus or minus 3%.
 - .2 Room sensors: plus or minus 2%.
- .4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
- .5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.
- .6 Room sensors: wall mounted as indicated.
- .7 Duct mounted sensors: locate so that sensing element is in air flow in duct.
- .2 Outdoor Humidity Requirements:
 - .1 Range: 0 - 100 % RH minimum.
 - .2 Operating temperature range: -40 - 50 degrees C.
 - .3 Absolute accuracy: plus or minus 2%.
 - .4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.
 - .5 Must be unaffected by condensation or 100% saturation.
 - .6 No routine maintenance or calibration is required.

2.5 Humidity Transmitters

- .1 Requirements:
 - .1 Input signal: from RH sensor.
 - .2 Output signal: 4 - 20 mA onto 500 ohm maximum load.
 - .3 Input and output short circuit and open circuit protection.
 - .4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.
 - .5 Output linearity error: plus or minus 1.0% maximum of full scale output.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect: plus or minus 1.0 % full scale/ 6 months.
 - .8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.6 Pressure Transducers

- .1 Requirements:
 - .1 Combined sensor and transmitter measuring pressure.
 - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
 - .2 Output signal: 4 - 20 mA into 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.

2.7 Differential Pressure Transmitters

.1 Requirements:

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

2.8 Static Pressure Sensors

.1 Requirements:

- .1 Multipoint element with self-averaging manifold.
 - .1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
- .2 Accuracy: plus or minus 1 % of actual duct static pressure.

2.9 Static Pressure Transmitters

.1 Requirements:

- .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
- .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
- .3 Accuracy: 0.4 % of span.
- .4 Repeatability: within 0.5 % of output.
- .5 Linearity: within 1.5 % of span.
- .6 Deadband or hysteresis: 0.1% of span.
- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.10 Velocity Pressure Sensors

.1 Requirements:

- .1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
- .2 Maximum pressure loss: 37Pa at 1000 m/s.
- .3 Accuracy: plus or minus 1 % of actual duct velocity.

2.11 Velocity Pressure Transmitters

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed 125 % of duct velocity pressure at maximum flow.
 - .3 Accuracy: 0.4 % of span.
 - .4 Repeatability: within 0.1 % of output.
 - .5 Linearity: within 0.5 % of span.
 - .6 Deadband or hysteresis: 0.1% of span.
 - .7 External exposed zero and span adjustment.
 - .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.12 Pressure And Differential Pressure Switches

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
 - .2 Adjustable setpoint and differential.
 - .3 Switch: snap action type.
 - .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
 - .5 Accuracy: within 2% repetitive switching.
 - .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
 - .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

2.13 Temperature Switches

- .1 Requirements:
 - .1 Operate automatically.
 - .2 Adjustable setpoint and differential.
 - .3 Accuracy: plus or minus 1 degrees C.
 - .4 Snap action rating: Switch to be DPST for hardwire and EMCS connections.
 - .5 Type as follows:
 - .1 Room: for wall mounting on standard electrical box with protective guard.
 - .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.

2.14 Electromechanical Relays

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

2.15 Solid 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.

2.16 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.

2.17 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.

2.18 Control Dampers

- .1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 mm high. Three or more sections to be operated by jack shafts.
- .2 Materials:
 - .1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
 - .2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
 - .3 Bearings: maintenance free, synthetic type of material.
 - .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
 - .5 Seals: synthetic type, mechanically locked into blade edges.
 - .1 Frame seals: synthetic type, mechanically locked into frame sides.
- .3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
 - .1 Size/Capacity: refer to damper schedule
 - .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.
- .4 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.
- .5 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 manufacturer's installation guidelines.
 - .4 Use same manufacturer as damper sections.

2.19 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.

2.20 Control Valves

- .1 Body: globe style.
 - .1 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
 - .2 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
 - .3 Packing easily replaceable.
 - .4 Stem, stainless steel.
 - .5 Plug and seat, stainless steel.
 - .6 Disc, replaceable, material to suit application.
 - .7 NPS 2 and under:
 - .1 Screwed National Pipe Thread (NPT) tapered female connections.
 - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
 - .3 Rangeability 50:1 minimum.
 - .8 NPS 2 and larger:
 - .1 Flanged connections.
 - .2 Valves to ANSI Class 150 or 250, valves to bear ANSI mark.
 - .3 Rangeability 100:1 minimum.
- .2 Butterfly Valves NPS 2 and larger:
 - .1 Body: for chilled water ANSI Class 150 cast iron lugged body installed in locations as indicated. For steam and heating water ANSI Class 150 carbon steel lugged body.
 - .2 End connections to suit flanges that are ANSI Class 150.
 - .3 Extended stem neck to provide adequate clearance for flanges and insulation.
 - .4 Pressure limit: bubble tight sealing to 170 kilopascals.
 - .5 Disc/vane: 316 stainless steel.
 - .6 Seat: for service on chilled water PTFE (polytetrafluoroethylene. For service on steam and heating water PTFE.
 - .7 Stem: 316 stainless steel.
 - .8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
 - .9 Maximum flow requirement as indicated on control valve schedule.
 - .10 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.
 - .11 Valves are to be provided complete with mounting plate for installation of actuators.

2.21 Electronic / Electric Valve Actuators

- .1 Requirements:
 - .1 Construction: steel, cast iron, aluminum.
 - .2 Control signal: 0-10V DC or 4-20 mA DC.
 - .3 Positioning time: to suit application. 90 sec maximum.

- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
- .8 Minimum shut-off pressure: refer to control valve schedule.

2.22 Watthour Meters And Current Transformers

- .1 Requirements:
 - .1 Include three phases, test and terminal blocks for watthour meter connections and connections for monitoring of current. Provide two transformers for 600 V 3 wire systems for watthour meter use. Accuracy: plus or minus 0.25 % of full scale. For chiller applications: to have instantaneous indicator with analog or digital display].
 - .2 Watthour meter sockets: to ANSI C12.7.
 - .3 Potential and current transformers: to ANSI/IEEE C57.13.
 - .4 Potential transformers: provide two primary fuses.
 - .5 Demand meters: configure to measure demand at 15 minute intervals.

2.23 Surface Water Detectors

- .1 Requirements:
 - .1 Provide alarm on presence of water on floor.
 - .2 Expendable cartridge sensor.
 - .3 Internal waterproof switch.
 - .4 One set of dry contacts 2 amps at 24 V.
 - .5 Unaffected by moisture in air.
 - .6 Self-powered.

2.24 Panels

- .1 wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required 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.

2.25 Wiring

- .1 In accordance with Division 26
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
 - .1 Field wiring to digital device: 20AWG stranded twisted pair.
 - .2 Analog input and output: shielded 20 minimum stranded twisted pair.

PART 3 EXECUTION

3.1 Installation

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, 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 00 - Common Work Results for Electrical.
 - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .3 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .4 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.
 - .5 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.
- .7 VAV Terminal Units: supply, install and adjust as required.
 - .1 Air probe, actuator and associated VAV controls.
 - .2 Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and actuators.
 - .3 Co-ordinate air flow adjustments with balancing trade.

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 Magnehelic Pressure Indicators

- .1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Departmental Representative.

3.5 Pressure And Differential Pressure Switches And Sensors

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
 - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.6 I/P Transducers

- .1 Install air pressure gauge on outlet.

3.7 Air Pressure Gauges

- .1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.
- .2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.8 Identification

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.9 Air Flow Measuring Stations

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.10 Testing And Commissioning

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
 - .1 Control Description Logic (CDL) for each system.
 - .2 Input/Output Point Summary Tables for each system.
 - .3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2 References

- .1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / 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>

1.3 Sequencing

- .1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.
- .2 Call Centre Split Air Conditioning System:
 - .1 The system is cooling only but is paired with the base buildings hydronic heating system for space heating.
 - .2 The split air conditioning system shall have a packed system of control to operate AC and CU units. All systems will be connected to a central controller that shall be interfaced with EMCS. From the EMCS operator work station, the operator will have to capability monitor alarms, adjust setpoints, revise schedules, and view status of perimeter heating control valve.
 - .1 Occupant space setpoint adjustment will be limited to +/- 2 C at the room thermostat.
 - .3 Fans shall run continuously (adjustable) on AC-2 and AC-4 (equipped with humidifiers).
 - .4 Fans shall run on cooling demand (adjustable) for AC-1 and AC-3.
 - .5 Cooling:
 - .1 On call for cooling, start respective split air conditioning system
 - .6 Heating:
 - .1 The space thermostats for the split air conditioning system shall also control and operate the call centers perimeter heating. On call for heating, modulate respective heat control valve open.
 - .7 Humidification:
 - .1 HU-1 and HU-2 serving AC-2 and AC-4 shall operate with packaged controls and sensors.

- .2 The humidifiers will maintain humidification setpoint 35%(adjustable) based on return air duct humidistat. Located humidistat in air transfer from call centre.
 - .3 Unit shall be locked out from operation using air flow proving switch in supply air duct as well as humidification high limit sensor.
 - .8 Interlocks:
 - .1 Interlock all split AC units with ERV-1.
 - .2 System shall not permit simultaneous heating and cooling
- .3 Spaces Served by Variable Air Volume Terminal Units and base building AHU-1:
 - .1 Sequence of operations for new VAV terminal units shall follow sequences of existing building VAV terminal units.
 - .2 Cooling:
 - .1 On call for cooling modulate damper open.
 - .3 Heating:
 - .1 Where perimeter heating is present, control heating of same thermostat as space VAV terminal unit.
 - .2 On call for heating, modulate damper to minimum position and modulate open perimeter heating control valve.
- .4 Server Room Split Air Conditioning System:
 - .1 The system is comprised of two split air conditioning systems, each sized to carry the anticipated Server Room load independently. Both units may operate simultaneously only if required.
 - .1 Provide a lead/lag alternating controller.
 - .1 Operate units on a weekly lead lag schedule.
 - .2 Both units shall operate if a single unit can not maintain the cooling setpoint.
 - .2 The split air conditioning system shall have a packed system of control to operate AC-5A/5B and CU-5A/B units. The system will be connected to a central controller that shall be interfaced with EMCS. From the EMCS operator work station, the operator will have to capability monitor alarms and adjust setpoints.
 - .3 Humidification
 - .1 Packaged humidistat with supply air discharge plenum.
 - .2 The humidifier will maintain humidification setpoint 35%(adjustable) based space humidistat.
 - .3 Unit shall be locked out from operation using humidification high limit sensor.
- .5 UPS Room Computer Room Air Conditioning System
 - .1 The system is comprised of two split computer room air conditioning systems, each sized to carry the anticipated UPS Room load independently. Both units may operate simultaneously only if required.
 - .1 Provide a lead/lag alternating controller.
 - .1 Operate units on a weekly lead lag schedule.
 - .2 Both units shall operate if a single unit can not maintain the cooling setpoint.

- .2 The computer room air conditioners shall have a packed system of control to operate AC-6A/B and CU-6A/B units. The system will be connected to a central controller that shall be interfaced with EMCS. From the EMCS operator work station, the operator will have to capability monitor alarms and adjust setpoints.
- .3 Humidification
 - .1 The computer room air conditioners shall have integrated, packaged humidifiers controlled by the units controller.
- .6 Alarms
 - .1 Provide high and low temperature alarms for all spaces with thermostat, including Server Room and UPS Room.
 - .2 Provide water or leak detection in the following rooms.
 - .1 Server Room: Provide two sensors. One located beneath AC units and one located beneath humidifier.
 - .2 UPS Room: Provide two sensors. One adjacent to AC-6A/B and one located at low point in room.
 - .3 Kitchenette area below sink
 - .4 In all rooms with humidifiers. Locate sensor just below humidifier unit
 - .3 Provide high and low humidity alarms in Server Room and UPS Room.
 - .4 Provide high water alarm for all sanitary lift pumps.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not Used.

PART 3 EXECUTION

3.1 Not Used

- .1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 CSA Group
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.
 - .2 CAN3-C235-83 (R2010), 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.

1.3 Definitions

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.4 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 and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit for review single line electrical diagrams under plexiglass and locate as indicated.
 - .1 Electrical distribution system in new electrical room
- .4 Shop drawings:
 - .1 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.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .3 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .4 Submit copies of drawings and product data to authority having jurisdiction.
 - .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .5 Certificates:
 - .1 Provide CSA certified equipment and material.

- .2 Where CSA certified equipment and material is not available, submit such material and equipment to 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.
- .6 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.

1.5 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for 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.

1.6 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: 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, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 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 nameplates for control items in English.

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 material and equipment are not available, obtain special approval from authority having jurisdiction 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 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems as shown on mechanical drawings and as specified in mechanical sections.

2.4 Warning Signs

- .1 Warning Signs: in accordance with requirements of Departmental Representative.
- .2 Decal signs, minimum size 175 x 250 mm.

2.5 Wiring Terminations

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.6 Equipment Identification

- .1 Identify electrical equipment with labels as follows:
 - .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core and mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters

Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on labels and nameplates to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. as directed by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

2.7 Wiring Identification

- .1 Identify wiring with permanent indelible identifying markings, numbered on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .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.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.
- .4 Colours to match that of the existing building systems.

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.
- .1 Paint indoor switchgear and distribution enclosures light gray.

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 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.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 Mounting Heights

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1050 mm.
 - .2 Wall receptacles:
 - .1 General: 450 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical/electrical rooms: 1050 mm.
 - .3 Panelboards: as required by Code or as indicated.

- .4 Fire alarm stations: 1050 mm.
- .5 Television outlets: Coordinate with architectural.

3.7 Co-Ordination Of Protective Devices

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.8 Field Quality Control

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Powerdistribution and generation system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm.
 - .6 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.

3.9 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.

3.10 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.18-98, Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No.65-03, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

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 wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

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 wire and box connectors for incorporation into manual.

1.5 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 in dry location, off ground, indoors 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.

PART 2 PRODUCTS

2.1 Materials

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of 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 sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for conductors copper.
 - .2 Clamp for copper conductors.
 - .3 Clamp for round aluminum bar.
 - .4 Stud clamp bolts.
 - .5 Bolts for copper conductors.
 - .6 Bolts for aluminum conductors.
 - .7 Sized for bars and conductors as indicated.
- .4 Clamps or connectors for armoured cable, mineral insulated cable, flexible conduit, 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 cables and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 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.
 - .3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.3 Cleaning

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

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 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 1000V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketted.
- .3 Neutral supported cable: 3 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.
- .4 All wiring to be copper.
- .5 All building wires are to be run in conduit.

2.2 Teck 90 Cable

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Cross-linked polyethylene XLPE.
 - .2 Rating:, 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: aluminum interlocking.
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 1500 mm centers.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
 - .1 Watertight approved for TECK cable.

2.3 Mineral-Insulated Cables

- .1 Conductors: solid bare soft-annealed copper, size as indicated.
- .2 Insulation: compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.
- .3 Outer covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 degrees C.
- .4 Overall jacket: direct burial.
- .5 Two hour fire rating.
- .6 Connectors: watertight, factory installed and approved for MI cable.
- .7 Termination kits: field installed approved for MI cable
- .8 All mineral insulated cables are to be continuous and without splices.

2.4 Armoured Cables

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Connectors: anti short connectors.

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 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 Install cable in trenches in accordance with Section 33 71 73.02 - Underground Electrical Service.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Conductor length for parallel feeders to be identical.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6 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.
- .7 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.

- .8 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.
 - .2 In underground ducts in accordance with Section 33.
 - .3 In underfloor distribution system in accordance with Section 21.
 - .4 In surface and lighting fixture raceways in accordance with Section 26.

3.4 Installation Of Teck90 Cable (0 -1000 V)

- .1 Group cables wherever possible on channels.
- .2 Install cable exposed, securely supported by hangers.

3.5 Installation Of Mineral-Insulated Cables

- .1 Install cable exposed, securely supported per manufacturer's recommendations.
- .2 Support 2 hour fire rated cables at 1 m intervals.
- .3 Make cable terminations by using factory-made kits.
- .4 Cable terminations: use thermoplastic sleeving over bare conductors.
- .5 Do not splice cables unless indicated.
- .6 Installation of mineral insulated cable is to be certified by a factory representative.

3.6 Installation Of Armoured Cables

- .1 Group cables wherever possible on channels.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 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.41-13, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
 - .3 CSA C22.2 No.65-13, Wire connectors (Tri-National Standard, with UL 486A-486B NMX-J-543-ANCE).

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 connectors and terminations and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: obtain inspection certificate of compliance covering high voltage stress from inspection authority and include it with maintenance manuals.

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 connectors and terminations for incorporation into manual.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 connectors and terminations from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Connectors And Terminations

- .1 Short barrel Copper and long barrel compression connectors to CSA C22.2 No.65 as required sized for conductors.
- .2 Contact aid for aluminum cables where applicable.
- .3 4, 3, 2 way joint boxes dry location type

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 connectors and terminations 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 stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2No.41.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 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.

1.3 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 grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

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 grounding equipment for incorporation into manual.

1.5 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, in dry location, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect grounding equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Equipment

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, soft annealed, size as indicated.

- .3 Rod electrodes: 19 copper clad steel mm diameter by minimum 3 m long.
- .4 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .5 Insulated grounding conductors: green, copper conductors, size as indicated.
- .6 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .7 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

PART 3 EXECUTION

3.1 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 copper welding by thermit process.
- .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 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .13 Ground secondary service pedestals.

3.3 Maintenance Holes

- .1 Install conveniently located grounding stud, electrode, size as indicated stranded copper conductor in each maintenance hole.
- .2 Install ground rod in each maintenance hole so that top projects through bottom of maintenance hole. Provide with lug to which grounding connection can be made. Confirm ground resistance meets or exceeds Canadian Electrical Code minimum requirements.

3.4 Electrodes

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .3 Install rod electrodes and make grounding connections as indicated.
- .4 Bond separate, multiple electrodes together.
- .5 Use size 3/0 AWG copper conductors for connections to electrodes.
- .6 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.5 System And Circuit Grounding

- .1 Install system and circuit grounding connections to neutral of secondary 120/208V system.

3.6 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.

3.7 Grounding Bus

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.
- .2 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 2/0AWG.

3.8 Communication Systems

- .1 Install grounding connections for sound, fire alarm, security systems, intercommunication systems as follows:

- .1 Sound, fire alarm, security systems, intercommunication systems as indicated.

3.9 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.

3.10 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

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 hangers and supports 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 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 off ground, in dry location, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hangers and supports from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Support Channels

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, hot dipped galvanized, suspended.
- .2 All fasteners to be galvanized type.

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 hangers and supports installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform DCC Representative 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 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1500mm on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 PRODUCTS

2.1 Junction And Pull Boxes

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on turned edge covers.

PART 3 EXECUTION

3.1 Junction, Pull Boxes And Cabinets Installation

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.2 Identification

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name and voltage and phase or as indicated.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit samples for floor box 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.

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.

2.3 Furniture Feed Floor Boxes

- .1 Designed to work in raised floor applications.
- .2 Constructed of die cast aluminum material
- .3 Furniture feed floor box able divided for dual service.
- .4 Provide 3" 76mm tall box with durable sheet metal cover.
- .5 Box to accept 6" 182mm round furniture feed covers.
- .6 The furniture feed box rated for commercial office

- .7 Box to be UL listed for Canadian safety standards and UL requirements under UL514A and UL514C for scrub water exclusion test for carpet.

2.4 Conduit Boxes

- .1 Cast aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

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 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M1981, 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, Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984, 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 21 - Construction/Demolition 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 Cables And Reels

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.

2.2 Conduits

- .1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel 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.
- .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.
- .6 Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3.

2.3 Conduit Fastenings

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
 - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1500mm on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 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 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.
- .4 Connectors and fittings to be steel.

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 Use rigid hot dipped galvanized steel threaded conduit when exposed to weather or moisture.
- .4 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury except in cast concrete
- .5 Use rigid pvc conduit underground.

- .6 Use flexible metal conduit for connection to motors in dry areas, connection to recessed lighting fixtures without prewired outlet box work in movable metal partitions and connection to surface or recessed fluorescent fixtures.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .8 Minimum conduit size for lighting and power circuits: 19 mm.
- .9 Install EMT conduit from branch circuit panel to outlet boxes located in access floor.
 - .1 Run flexible conduit from junction box to furniture feed floor box and junction box in consoles in access floor.
- .10 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .11 Mechanically bend steel conduit over 19 mm diameter.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.
- .14 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .15 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 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .6 Where possible, run conduits grouped on suspended channels.
- .7 Do not install conduits horizontally on walls and partitions, use rack suspended option.

3.4 Concealed Conduits

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.

3.5 Conduits Underground

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

3.6 Cleaning

- .1 Proceed in accordance with Section 01 74 11 - 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 Related Requirements

- .1 This Section covers items common to Divisions 26 and 28. These sections supplement requirements of Division 1.

1.2 References

- .1 CSA International
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.

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 network lighting controls and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Complete assembly.
 - .2 Contact surfaces.
 - .3 Construction features.
 - .4 Wiring diagrams.

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 network lighting controls for incorporation into manual.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect network lighting control from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 System Description

- .1 Operation: Input signal from digital signal sources switch or dim DALI devices associated with LED drivers, fluorescent lighting fixtures and other Lighting Control System end devices.
 - .1 Each device is connected to a digital data bus.
 - .2 Each DALI device has a digital address and be operated by a digital signal.
 - .3 Each device can be assigned to any or all of 16 available groups connected to a single data bus.
 - .4 Each LED driver may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to LED drivers and may be applied to groups.
 - .5 Each fluorescent ballast may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to fluorescent ballasts and may be applied to groups.

2.2 Performance Requirements

- .1 DALI Requirements
 - .1 Components: Individually addressable devices (such as LED drivers, dimmers and switches) that are operated from digital signals received through a DALI-compliant bus, from data-entry and retrieval devices (such as PCs, personal digital assistants, hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs). Devices also report status to data-entry and retrieval devices through the bus.
 - .2 Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component shall be automatically isolated and not affect global system functions.
- .2 System Requirements
 - .1 Emergency Default: The LCS and lighting end devices must revert to a safe and acceptable default state in the event of a loss of the DALI bus situation. In order for the default state to be considered safe and acceptable, it must meet the following specifications:
 - .1 Loss of Power to the Lighting Control Panels: All lighting control panels are to be supplied with power from non-emergency circuits. In the event that power is lost to the lighting control panel, all of the led drivers that are connected to it shall revert to the full power (On) state and remain in this state until power is restored and they are commanded otherwise.

Loss of Power to Emergency Circuits: In the event that power is lost to the emergency circuits that are supplied by emergency fixtures shall automatically revert to the default closed (On) position. When backup power is activated all led drivers that are supplied by emergency circuits shall revert to the full power state and remain in this state the instant that backup power is activated until commanded otherwise.
 - .2 Tamper Proof Settings: The default settings (or any other settings that pertain to the operation of the LCS during emergency conditions) of all lighting control equipment, DALI led drivers and lighting shall not be capable of being modified through either a manual or software provision by the user of the LCS.

- .3 UL 924 listed components: The default settings (or any other settings that pertain to the operation of the LCS during emergency conditions) of UL 924 listed components shall not be capable of being modified either manually or via software by the user, person responsible for commissioning or the manufacturer.
- .2 Central Control: All operating parameters of the LCS shall be configured from a central point of access through a web browser.
- .3 Remote Access: All operating parameters of the LCS shall be configurable from any computing device with a web browser and an internet browser.
- .4 User Access: The end user shall be capable of applying administrative rules to restrict the access privileges of each user. Access restrictions shall be applicable to the set of fixtures as well as the feature set available for those fixtures.
- .5 System Clock: The time clock of the LCS shall be synchronized to internet standard time.
- .6 Power Failure: The lighting system shall resume operation after a power outage to the state that it would have been in if the power outage had never occurred.
- .7 Loss of Communication: DALI devices shall operate at a user-specified level in the event that communication is lost to the control panel.
- .8 Time Scheduling: The daily power consumption cycle of each fixture shall be regulated by a programmable scheduling routine.
- .9 Daylight Harvesting: The lighting system shall adjust light levels in response to varying ambient light levels in order to maintain a constant, user-specified light level at desk height. Ambient light levels shall be read from a network of daylight sensors that are distributed throughout areas that are candidates for daylight harvesting. Intelligent algorithms shall be used to minimize the number of sensors required.
 - .1 Daylight Sensor Groupings: The set of light fixtures that are controlled by a given daylight sensor can span multiple DALI communication busses, shall be configurable through software and shall not require any manual wiring to modify. The system shall allow for light fixtures to be added or removed from given daylight sensor group through web software.
 - .2 Daylight Sensor Settings: All settings that govern the behavior of a given daylight sensor shall be adjustable through web software and shall not require any physical adjustment to the sensor itself.
 - .3 Gradient Dimming: A single daylight sensor working in conjunction with lighting software shall be capable of providing separate control for up to 16 groups of light fixtures. Each group of light fixtures can have unique settings, including the lighting set point, so that location-specific conditions can be accommodated by a single sensor. Gradient dimming will allow for the row of light fixtures closest to the window to dim more than the next closest row of light fixtures (the third closest row dims more than the second closest row and so on for the 4th, 5th...16th rows) even though all rows are controlled by the same single sensor. Electronic Enable/Disable: The daylight sensor shall be enabled and disabled through software in order to manage its operation on a scheduled daily basis.
- .10 Personal Control: Users shall customize the lighting levels in their own workspace. Building Management can apply restrictions to the range of lighting levels that can be programmed by each occupant to ensure conservation target are met. Access is provided from any computer or hand-held device that is

connected to the internet. The light level of each fixture shall be controllable from 0-100%, in increments of 1%, for a specified duration of time.

- .1 Number of Simultaneous Users: The system shall accommodate a minimum of five hundred (500) simultaneous web users.
- .2 Support Web Browsers: Microsoft Internet Explorer 11 or higher, Google Chrome 40 or higher.
- .11 Occupancy Detection: The system shall reduce the power consumption in vacant areas by reading the status of a network of low voltage occupancy sensors.
 - .1 DALI Occupancy Sensor Wiring: DALI capable occupancy sensors shall be wired directly to the two-wire DALI communication bus.
 - .2 Low Voltage Occupancy Sensor Wiring: Low voltage occupancy sensors shall be wired to the DALI Powerpack as defined by the sensor type. This permits the Low Voltage Occupancy Sensor to obtain an individual DALI address.
 - .3 Occupancy Sensor Groupings: The set of light fixtures that are controlled by a given occupancy sensor can span multiple DALI communication buses, shall be configurable through software and shall not require any manual wiring. The system shall allow for light fixtures to be added or removed from given occupancy sensor group through web software.
 - .4 Occupancy Sensor Settings: All settings that govern the behavior of a given occupancy sensor shall be adjustable through web software and shall not require any physical adjustment to the sensor itself.
 - .5 Occupancy Sensor Levels: Each occupancy sensor shall have a total of five (5) programmable lighting levels. These levels are defined as follows:
 - .1 Occupied Level: The Occupied Level represents the light level that fixtures will be commanded to when occupancy is detected. Light levels will remain at the Occupied Level until occupancy is no longer detected.
 - .2 Transition Levels: Transition Levels provide a gradual change in light levels when occupancy is no longer detected. Three (3) Transition Levels, each of which can be programmed with different light levels and timer values shall be provided.
 - .3 Vacancy Level: The Vacancy Level represents the light level that fixtures will be commanded to when occupancy is no longer being detected and all Transition Levels have expired.
 - .4 Electronic Enable/Disable: The occupancy sensor shall be enabled and disabled through software in order to manage its operation on a scheduled daily basis.
- .12 Monitoring: The operational status of all system hardware and software components shall be routinely checked. Faults with led drivers and every other component of the system shall be automatically detected and electronic notifications shall be distributed. These notifications clearly illustrate the location of the device on the floor plan and the time that the fault was detected.
- .13 Reporting: The energy consumption of the lighting system shall be viewed, tracked and recorded. Data shall be charted according to user-defined zones, which can be as small as an individual fixture or as large as a portfolio of buildings. Savings shall be presented in terms of energy, dollars and greenhouse gas emissions (if requested). The data presented is a computed value and does not require the installation of additional hardware. Alternatively, this software can

- be integrated with a physical metering system to present revenue grade energy measurements.
- .14 Partitioning: The system shall allow users to define a space as a partitioned space. Users can define partitioned areas with up to four (4) sub-areas per partitioned area with specific control strategy for each sub-area. When the partitions/dividers are open, the space is used as one large room. When the partitions/dividers are close, each sub-area has a dedicated lighting control.
 - .15 Load Shedding: The system shall allow the building manager to apply a customized load shed reduction level to select devices. The system shall allow users to lock certain devices so that the light levels cannot be manipulated or overridden by users. Loading shedding shall be triggered via a maintained contact closure signal from an emergency system, PLC or certified OpenADR device.
 - .16 Off-Hour Access: The system shall only activate the set of lights required by an occupant to perform their work during the off-hour time period. The system shall avoid turning on an entire quadrant or floor for when only an office, hallway and washroom are required. These lights can be activated in several ways, including a pass card, phone system or web software. Cleaning staff are accommodated by a programmed turn-on and shut-down sequence, which illuminates their work area in successive fashion.
 - .17 Zoning: The system shall be capable of configuring zones via software and avert the need to re-wire certain power distribution circuitry and lighting equipment as tenancy patterns change.
 - .18 Multi-Building Control: The LCS shall be capable of connecting to an off-site datacenter so that it can be operated as part of a multiple building control network.
 - .1 Data Consolidation: Buildings operating on the multiple building networks shall have all information consolidated to a single report and view on the web interface. This allows for the total energy consumed by all buildings to be displayed in a single graph rather than one graph for each building. Information relating to the all reporting and monitoring functions (as described in this specification) shall be consolidated in this manner.
 - .19 Override Management: The system shall be capable of handling several different commands targeted at the same fixture in a manner that is logical, pre-defined and acceptable to the end customer.
 - .20 Graphical User Interface: The visual interface of the software shall import the floor plan design file in DXF or DWG format. All lighting fixtures, sensors and other components of the lighting system contained in the floor plan design file shall be recognized by the software and rendered into interactive objects on the graphical user interface.

2.3 Integration

- .1 Network Convergence
 - .1 The LCS shall transmit data on the same Ethernet Communication Network used for computers, VOIP telephones and other IP devices running in the facility.
 - .2 The LCS shall not incur noticeable latencies by running on the unified network.
 - .3 The LCS shall operate with the same network hardware used for routing standard TCP/IP data packets.
 - .4 The LCS server shall be either a physical server installed within an IT space or installed on a virtual machine.

- .5 The LCS shall not communicate using Multi-Cast or Broadcast IP traffic messages.
- .6 The LCS shall be capable of using either fixed IP addresses or DHCP and hostnames.
- .7 The LCS shall utilize up to 2048 bit encryption on all Web Server user sessions and third party Web Service communications.
- .2 BAS Integration
 - .1 The integration of the LCS and other Building Automation Systems (BAS) shall meet the objectives listed as follows:
 - .1 Provide the ability to communicate with the BAS via BACnet IP
 - .2 Requires only one network connection per system
 - .3 The BMS system shall be able to discover the following objects via the BACnet Interface shall support the following commands:
 - .1 Read device (DALI device) status
 - .2 Read Lamp status
 - .3 Read Light level
 - .4 Read what override is active
 - .5 Send override to a device
 - .6 Set override type (high priority, normal)
 - .7 Set light level
 - .8 Set duration
 - .9 Calling Preset DALI scene
 - .10 Set scene ID
 - .11 Set duration for a scene
 - .12 Set scene level
 - .13 Read lights on/off status for a group of fixtures
 - .14 Send override to a group of fixtures
 - .15 Set light level for a group of fixtures
 - .16 .Read ballast status for a group of fixtures
 - .17 Read lamp status for a group of fixtures
 - .18 Read power consumption for a group of fixtures
 - .19 Set Light level for a group of fixtures via scenes
 - .20 Set the priority of the override command sent to a group of fixtures
 - .21 Read occupancy sensor status
 - .22 Read daylight sensor reading
- .3 VOIP Telephone System
 - .1 The LCS shall support the following models of VOIP telephones by publishing an application designed specifically for the unique user interface of each phone:
 - .1 Cisco Unified IP Phone 7906G2
 - .2 Cisco Unified IP Phone 7911G3
 - .3 Cisco Unified IP Phone 7931G4
 - .4 Cisco Unified IP Phone 79405
 - .5 Cisco Unified IP Phone 7941G6

- .6 Cisco Unified IP Phone 7942G7
- .7 Cisco Unified IP Phone 7945G8
- .8 Cisco Unified IP Phone 7960G9
- .9 Cisco Unified IP Phone 7961G10
- .10 Cisco Unified IP Phone 7962G11
- .11 Cisco Unified IP Phone 7965G12
- .12 Cisco Unified IP Phone 7975G13
- .13 Cisco Unified IP Conference Station 7937G
- .2 Features:
 - .1 The following user features shall be provided through the VOIP telephone system:
 - .1 Dimming control over lights on a group and individual fixture basis.
 - .2 Scene control over lights on a group and individual fixture basis.
 - .3 Tube fault detection.
 - .4 Service report and dispatch.
- .3 User Access
 - .1 The set of lights controlled by a given VOIP telephone shall be regulated through a user access policy.
 - .2 The user access policy shall allow for each VOIP telephone to control a unique set of light fixtures.
 - .3 Facility managers shall be able to regulate the set and number of fixtures assigned to a given user.
 - .4 The LCS shall link each user to a VOIP telephone based on the unique identifier of the VOIP telephone.
 - .5 The set of lights controlled by a given VOIP telephone shall be regulated based on the access level of the user associated with the unique identifier of the VOIP telephone.
- .4 Number of Simultaneous User Connections
 - .1 The LCS shall be capable of supporting five thousand (5,000) simultaneous VOIP telephone connections.
 - .2 The LCS shall not incur noticeable latencies when multiple users send commands through the VOIP telephones at the same time.
- .5 Wiring
 - .1 The LCS shall connect to the VOIP telephone system through a single Ethernet connection point.
 - .2 The LCS and the VOIP telephone system shall exchange data through an XML Web Services Protocol.
- .6 User Set Up
 - .1 The LCS shall provide a user set up application consisting of a visual interface that is accessible by the supported web browsers to set up each VOIP telephone user.
 - .2 The user set up application shall import the DXF file and provide a visual mechanism to link each user to their respective lighting fixtures.
- .7 XML Integration

- .1 Transmission of data between the LCS and 3rd party systems using Web Services.
- .2 The XML Integration shall publish all key operating parameters of the LCS for the read and write operations required to implement intelligent integration strategies.
- .3 XML Integration can be used for AV integration, Fire, Security and other 3rd party coordination.
- .4 Control: The XML interface shall provide read/write access to all LCS end devices.

2.4 Controller/Gateways

- .1 Lighting Control Panels
 - .1 Internal circuitry shall be protected by a fused receptacle.
 - .2 Shall provide Class I/II NEC separation.
 - .3 Lighting Control Panel shall include a Local Controller to host the web-based software application and data.
 - .4 Lighting Control Panel shall include the DALI Bus Controller as an interface between the web-based software application and lighting led drivers, sensors, keypads and low voltage switches.
 - .5 Lighting Control Panel shall provide 2-way communication to software application via an Ethernet protocol.
 - .6 Lighting Control Panel shall provide 2-way communication to lighting led drivers via the DALI protocol.
 - .7 The Lighting Control Panel shall include the required hardware to interface with low voltage analog devices and maintained or momentary digital devices..
 - .8 Lighting Control Panel shall be mounted in a tamper-proof electrical cabinet.
 - .9 The Lighting Control Panel shall allow remote diagnosis of its operational status.
- .2 Local Controllers
 - .1 Each Lighting Control Panel shall have a Local Controller
 - .2 The Local Controller shall:
 - .1 Host the control application as well as the user interface to manage the devices connected to the Lighting Control Panel.
 - .2 Have a configurable IP address
 - .3 Support up to 32 distributed DALI buses.
 - .4 Support up to 256 digital and analogue low voltage devices
 - .5 Provide limited interfaces for integration with building management systems and IP telephony:
 - .1 5 Mobile Users,
 - .2 250 BACnet objects,
 - .3 25 VOIP phone connections.
- .3 Central Manager
 - .1 The Central Manager shall acts as a system wide historian and global database that holds the system's event journal.

- .2 The Central Manager shall allow user to manage the lighting system centrally. All changes made from the Central Manager shall automatically replicate to the local controllers connected to the Central Manager.
- .3 The Central Manager shall be installed within an IT space or installed on a virtual machine.
- .4 The Central Manager shall provide data security methods for backup and restore capabilities.
- .4 Virtual Central Manager
 - .1 The Virtual Central Manager shall be installed on a VMWare® based virtual machine
 - .2 The Virtual Central Manager shall provide the same functional as the Central Manager.
- .5 The DALI Bus Controller (DBC) links the distributed data buses with a USB connection to the Local Controller. The Local Controller provides computer configuration, control, analysis and maintenance. The DBC and Local Controller operate independently and continue to process local inputs and schedules when disconnected from the LAN. The DBC and Local Controller shall provide local intelligence and features including the following:
 - .1 Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.
 - .2 Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.
 - .3 Computer Monitoring and Configuration: The DBC and Local Controller shall allow configuration, monitoring and analysis from PCs on the Ethernet LAN.
- .6 Each data bus shall have the capacity to control 64 addressable devices, using NFPA 70, Class 2 control circuit.
 - .1 Each data bus shall have the capacity to control up to 16 groups and scenes.
 - .2 LED indicator lights for Ethernet status (link, send and receive), power-on and LAN failure.
 - .3 Linking of switch and sensor inputs to LED driver outputs.
 - .4 Viewing LED driver output status.
 - .5 Controlling LED driver outputs.
 - .6 Setting device addresses.
 - .7 Assigning switch and sensor inputs to LED driver output modes.
- .7 Allow connection of the following DALI-compliant addressable devices:
 - .1 Integral luminaire switching and dimming ballast and drivers.
 - .2 0-10V dimming modules.
 - .3 Two-wire dimming modules.
 - .4 Occupancy and photoelectric sensors.
 - .5 Low voltage powerpacks.
 - .6 Wallstations for user interface functionality.

2.5 User Interfaces

- .1 Workstation:

- .1 A laptop PC, with Microsoft Windows operating system and access to the web-based LCS management software.
- .2 Include licenses, documentation and storage media and licensing for a minimum of five (5) concurrent users.
- .2 DALI Wallstations
 - .1 DALI wallstations shall provide continuous dimming control via a DALI connection to a Lighting Control Panel.
 - .2 DALI Wallstation Wiring: DALI wallstations shall not be part of the DALI bus wiring to the Lighting Control Panel.
 - .3 DALI Wallstation Groupings: The set of light fixtures that are controlled by a given button shall be configurable through software and shall not require any manual wiring. The system shall allow for light fixtures to be added or removed from given groups through web software.
 - .4 DALI Wallstation Settings:
 - .1 All settings that govern the behavior of the wallstation buttons shall be adjustable through the Lighting Management Software and shall not require any physical adjustment to the device itself.
 - .2 The buttons behavior shall be programmable using conditional logic off of a state variable such as time of day or partition status.
 - .3 A button shall support three level toggles, i.e. three different Go to level commands.
 - .5 Dynamic Duration: All commands sent from the wallstation shall expire after a specified time period. The duration of this time period shall be programmable, based on the time of day that the wallstation is activated. This will allow for the time duration to differ at various times of day. Each keypad can have a different dynamic duration.
 - .6 DALI Wallstation Functionality:
 - .1 DALI wallstations shall provide one touch On/Off functionality as well as press and hold dimming.
 - .2 Different groups of lights shall be assigned to different buttons on each wallstation.
 - .3 The same button can be used to control lights and shades.
- .3 Low Voltage Wallstations
 - .1 Low voltage wallstations shall provide continuous dimming control via a low voltage connection to a Lighting Control Panel.
 - .2 Low Voltage Wallstation Wiring: Low voltage wallstations shall not be wired to switch the AC power line nor shall they be wired directly to any lighting led drivers or any other lighting end device. Low voltage wallstations shall only be wired to a low voltage lighting control panel through a multi (X) conductor, low voltage cable that meets the following specifications: 16AWG/X, plenum rated, FT6; where X is the number of buttons on the keypad plus one (1).
 - .3 Low Voltage Wallstation Groupings: The set of light fixtures that are controlled by a given button shall be configurable through software and shall not require any manual wiring. The system shall allow for light fixtures to be added or removed from given groups through web software.
 - .4 Low Voltage Wallstation Settings: All settings that govern the behavior of a given wallstation shall be adjustable through web software and shall not require any physical adjustment to the device itself.

- .5 Dynamic Duration: All commands sent from the wallstation shall expire after a specified time period. The duration of this time period shall be programmable, based on the time of day that the wallstation is activated. This will allow for the time duration to differ at various times of day. Each keypad can have a different dynamic duration.
- .6 Low Voltage Wallstation Functionality: Low voltage wallstations shall provide one touch On/Off functionality as well as press and hold dimming. Different groups of lights shall be assigned to different buttons on each keypad.
- .4 Touchscreen Controllers
 - .1 Communication: Internet Protocol.
 - .2 Interface: 5.7" resistive touch screen.
 - .3 Connections: wired directly to the lighting control network (or network switch) via a Cat5e Ethernet connection.
 - .4 Power: 24 VDC power supply.
 - .5 Touchscreen Functionality: Touchscreens shall accommodate custom dimming levels and time durations over multiple groups of fixtures. Touchscreen shall also be programmable to apply multiple pre-set lighting scenes as defined through the web software.
 - .6 Customization: Touchscreens shall have the ability to stream custom graphics or interfaces, depending on user need.
 - .7 Groups and settings: All touchscreen attributes, including fixture groups, scenes and graphical interface, shall be customizable through the software and shall not require rewiring or reprogramming at installed location for required changes.
- .5 Personal Digital Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier. The software shall provide for all DALI-protocol programming commands to be applied to the controller/gateway via a tethered connection.
- .6 Infrared Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches.

2.6 Lighting Management Software

- .1 Provide system software license that is designed, manufactured and warranted by a single manufacturer.
- .2 Lighting Management Software capabilities:
 - .1 Allows user to program, configure and manage the lighting system from a web browser over a TCP/IP connection, i.e. no software application is required to be installed on a remote client (example: desktop, laptop) to access the Lighting Management Software
 - .1 Support web browser: Microsoft Internet Explorer, Google Chrome
 - .2 Supports multiple platforms and devices: tablet, desktop, laptop, smartphone
 - .3 Optimized for displays of 1024 by 768 pixels or higher
 - .2 Allows manufacturer specialist, end user to:
 - .1 Design the system:
 - .1 Import CAD drawings of the building and automatically identify device types (wallstations, fixture types, etc...)
 - .2 Define schedule profiles

- .3 Define scenes
- .4 Define fixture types
- .5 Configure wallstations buttons
- .6 Define occupancy/vacancy sensor profiles
- .7 Define daylighting profiles
- .8 Define partitioned/sub-areas
- .9 Define emergency lighting
- .10 Define Fire alarm
- .11 Configure shade interface
- .12 Configure BAS interface
- .2 Startup
 - .1 Provide address to each device
 - .2 Adjust daylighting profile
- .3 Maintain
 - .1 View
 - .2 Monitor the status of each device
 - .3 Energy and Power consumption per building, floor, group of devices, device

2.7 Fixture Switching And Dimming

- .1 Each LED driver or group shall be addressable and shall include On/Off, fade, dimming, scene settings and other standard DALI control functions and are required to meet the sequence of operation.
- .2 LED drivers:
 - .1 Starting Method: Turns On at previously set light level.
 - .2 Dimming Range: 100 to 10 percent of rated lumens, unless otherwise indicated.
 - .3 Input Voltage Range: 108 to 305V.
- .3 0-10V Addressable Dimming Modules (Digital to Analog Converter DALI DAC)
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Communication Connections: Two wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Power Ratings: Up to 4A Ballast 120/277/347 VAC.
 - .6 Dimming Control: 0-10V, 50 mA max current sink.
 - .7 Mounting: Fixture or conduit (90° elbow and mounting clips included).
 - .8 UL 924 Listed component.
- .4 Addressable Dimming Modules
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.

- .4 Communication Connections: Two wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
- .5 Power Ratings: Up to 20A, 120 VAC.
- .6 Dimming Control: Forward phase dimming control for incandescent and magnetic low voltage loads.
- .7 Mounting: Junction box.
- .8 Control and communication operations of the ballast shall be immune to noise and power disturbances.
- .5 Driver shall meet the following operating parameters:
 - .1 Operating Voltage: 120 to 347 VAC (+5%/-10%) as per application requirements.
 - .2 Protection: End of lamp life and inrush current limiting circuitry.
 - .3 Warranty: Five (5) years.
 - .4 Bi-directional digital communication.
- .6 The ballast shall be wired per manufacturers recommendations.
 - .1 The ballast must be properly grounded to earth ground.
 - .2 The maximum length of blue and red wires shall not exceed three (3) ft.
 - .3 The maximum length of the yellow wires (when needed) shall not exceed four (4) ft.
- .7 Driver shall return the following programmable parameters:
 - .1 Power on level.
 - .2 Short, search and random addresses.
 - .3 Groups 0-7 and 8-15.
 - .4 Scenes 0-15.
 - .5 Minimum and maximum dimming levels.
 - .6 Fade time and fade rate.
 - .7 System and power failure levels.
 - .8 Physical minimum level.
 - .9 Device type.
 - .10 Version number.
- .8 Driver shall return the following status parameters:
 - .1 Actual dim level.
 - .2 Ballast status and tube status.
 - .3 Lamp power On.
 - .4 Limit error.
 - .5 Reset state.
 - .6 Missing short address.
 - .7 Contents of volatile memory.

2.8 Sensors

- .1 Addressable Multi-Sensors

- .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Sensing Technologies: Occupancy, daylight and temperature.
 - .6 Daylight Sensing Range: 0-400 lux.
 - .7 Daylight Sensing Coverage: Light input within 60° cone.
 - .8 Occupancy Detection Technology: Passive infrared.
 - .9 Occupancy Detection Coverage Area: 600 sq. ft. or 1,200 sq. ft.
 - .10 Occupancy Detection Angle: 360°.
 - .11 Mounting: Junction box or ceiling tile.
 - .12 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span multiple DALI communication buses.
 - .13 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours.
- .2 Low Voltage Occupancy Sensors
- .1 Communication: Low voltage signal.
 - .2 Power: From lighting control panel or DALI Powerpack.
 - .1 Lighting Control Panel Connections: Three (3) wires for power, control and common (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated).
 - .2 DALI Powerpack Connections: Five (5) wires for power, control, common, daylighting and commissioning (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated).
 - .3 Occupancy Sensing Technologies: Dual Technology, PIR (Passive Infrared) and/or Ultrasonic technology.
 - .4 Occupancy Detection Coverage Area: Options available from 500 sq. ft. or 2,000 sq. ft.
 - .5 Occupancy Detection Angle: 360° or linear.
 - .6 Mounting: Junction box or ceiling tile.
 - .7 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span multiple DALI communication buses.
 - .8 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours.

2.9 Low Voltage Devices

- .1 Infrared Transceiver and Receiver:
 - .1 Product: IRTR
 - .2 Provide contact closure based on status of the partition wall (open/close) enabling automatic update of the lighting control logic within the partitioned space.

2.10 Conductors And Cables

- .1 Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low Voltage Electrical Power Conductors and Cables."
- .2 Class 2 Control Cables: Multi-conductor cable with copper conductors no smaller than No. 18 AWG, complying with Section 260519 "Low Voltage Electrical Power Conductors and Cables."
- .3 Class 1 Control Cables: Multi-conductor cable with copper conductors no smaller than No. 14 AWG, complying with Section 260519 "Low Voltage Electrical Power Conductors and Cables."
- .4 Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable.
- .5 Communication wires shall be polarity insensitive and shall not require shielding or twisting. Plenum rated 18 AWG 2 conductor cable shall be sufficient.
- .6 Control wires shall be rated for the voltage of the power supply in order to be capable of being run in the same conduit as power wires.
- .7 Communication wires shall be capable of withstanding connection to the line voltage for an indefinite period of time without incurring any damage.
- .8 All conductors and cables are to be installed in conduit minimum 21mm.

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 network lighting controls 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 system and components in accordance with manufacturer's instructions.
- .2 Install starter cables to circuit outlet boxes and connect to power circuit and energize.
- .3 Install Smart-Light enclosures as shown on drawings and connect starter cable to power-in plug.
- .4 Connect joiner cables to each of power-out receptacles to first luminaire of controlled circuit as shown.
- .5 Install joiner cables between interceptors in fixtures or equipment. Allow extra cable to facilitate removal and relocation of fixtures or equipment.
- .6 Install blanking plugs in unconnected receptacles.

- .7 Integrally moulded thermoplastic components to match colour identification system (i.e. black for normal power, red for emergency power).
- .8 Install low voltage switch kits and low voltage cables as shown on drawings and connect to control ports of controlled circuits.
- .9 Install sensor kits and low voltage cables as shown on drawings and connect to control ports of controlled circuits.
- .10 Install central control kit from each or grouped Smart-Light enclosure to central control panel as shown on drawings.
 - .1 Connect to control port of Smart-Light as indicated.
 - .2 Connections within central control panel as instructed by control manufacturer.
- .11 All system wiring to be installed in conduit.

3.3 Field Quality Control

- .1 On completion of installation, manufacturer representative shall be notified to carry out site inspection and report any inconsistencies to the Departmental Representative. Corrections are to be implemented to comply with manufacturer's report.

3.4 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.5 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by network lighting controls installation.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Division 26. These sections supplement requirements of Division 1.
- .2

1.2 References

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.47, Air-Cooled Transformers (Dry Type).
 - .2 CSA C9, Dry-Type Transformers.
 - .3 CAN/CSA-C802.2, Minimum Efficiency Values for Dry Type Transformers.
- .2 National Electrical Manufacturers Association (NEMA)

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 dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

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 dry type transformers for incorporation into manual.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dry type transformers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Design Description

- .1 Design 1.

- .1 Type: ANN.
 - .2 3 phase, 600 V input, 208/120 V output, 60 Hz, kVA as shown on drawings.
 - .3 Copper windings.
 - .4 Voltage taps: standard 2 ½% full capacity above and below normal.
 - .5 Insulation: Class H, 150°C temperature rise.
 - .6 Basic Impulse Level (BIL): standard
 - .7 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .8 Hipot: standard
 - .9 Copper windings.
 - .10 Tin plated copper bus
 - .11 Winding configuration to be as noted on drawings.
 - .12 Harmonic Mitigating Phase Shifting transformers as indicated on drawings.
 - .13 KL-Rated Transformers as indicated on drawings.
 - .14 Voltage Regulation to be 4% or better.
 - .15 K13 where indicated.
 - .16 Average sound level: 55 db maximum.
 - .17 Impedance at 170°C: 5% up to 150 KVA, 4-5% over 150 KVA.
 - .18 Enclosure: EEMAC 3R, removable metal front panel complete with sprinkler proof hood.
 - .19 Complete with internal "anti-vibration pads" and "vibration isolators" and external vibration isolators.
 - .20 Mounting: floor or wall as required.
- .2 Two winding or T connected transformers are not acceptable.

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Label size: 7.

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 dry type transformers 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 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers above 75 kVA on floor.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Make conduit entry into bottom 1/3 of transformer enclosure.
- .10 Utilize a minimum of 1.0m of flexible cable for connection entering and exiting of transformers.

3.3 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.

3.4 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by dry type transformers installation.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26 and 28. These sections supplement requirements of Division 1.
- .2

1.2 Reference Standards

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C37.20.1-02, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
 - .2 ANSI/IEEE C37.20.2-1999, Standard for Metal-Clad and Station-Type Cubicle Switchgear.
 - .3 ANSI/IEEE C37.35-1995, Guide for the Application, Installation, Operation, and Maintenance of High-voltage Air Disconnecting and Interrupter Switches.
 - .4 ANSI/IEEE 241-1990, Recommended Practice for Electric Power Systems in Commercial Buildings.
 - .5 ANSI/IEEE 1015-06, Blue Book IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
- .2 CSA International
 - .1 CSA C22.2 No.31-10, Switchgear Assemblies.

1.3 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for interlock systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 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: 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 interlock systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Interlock Systems

- .1 Kirk key interlocks, Type D for switchboard main breaker and tie breaker to prevent:
 - .1 Closing of both switchboard main circuit breakers while tie breaker is closed.

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 interlock systems 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 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26 and 28. These sections supplement requirements of Division 1.

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 switchboards and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Maintenance Material Submittals

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide spare parts as recommended by manufacturer for maintenance period of 2 years minimum.

1.4 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: 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 switchboards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Standard Features

- .1 Switchboards shall be fully self-supporting structures with 90 inch tall vertical sections (excluding lifting eyes and pull boxes) bolted together to form required arrangement.
- .2 Switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation.
- .3 All sections may be rolled, moved or lifted into position. Switchboards shall be capable of being bolted directly to the floor without the use of floor sills.

- .4 All switchboard sections shall have open bottoms and removable top plate(s) to install conduit.
- .5 Front-Connected switchboard sections shall be rear aligned for placement against a wall. Front/Rear-Access switchboards shall be front and rear aligned.
- .6 Switchboards shall be UL listed.
- .7 Switchboards that are series rated to short circuit requirements shall be appropriately labeled. Tested UL listed combination ratings shall be included in UL recognized Component Directory (DKSY2).
- .8 All covers shall be fastened by hex head bolts.
- .9 Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.
- .10 Switchboard protective devices shall be furnished as listed on drawings and specified herein, including interconnections, instrumentation and control wiring. Switchboards and devices shall be rated for the voltage and frequency listed on the drawings.
- .11 Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 40 degree C per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65 degrees C in a 40 degree C ambient environment.
- .12 Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.
- .13 The group mounted feeder breaker and/or main devices within switchboards shall be circuit breakers or fusible switches as indicated on the drawings. Mounting for the group mounted circuit breakers shall be by bolted connections.

2.2 Incoming Features

- .1 Incoming section shall be direct cable connection to main breaker
- .2 Furnish switchboard(s) arranged for top entry of incoming cable.
- .3 Provide mechanical lugs in the quantity and size required per the contract drawings. All lugs shall be tin-plated copper and UL listed for use with copper cable. Lugs shall be rated for 75 degree C.

2.3 Bus Bars

- .1 Bus bars shall be silver-plated copper. The bus bars shall have sufficient cross sectional area to meet UL 891 temperature rise requirements. Phase and neutral bus ampacity shall be as shown on the plans. The neutral bus shall have the same ampacity as the phase bus.

- .2 Bus bars shall be mounted on high impact, non-tracking insulated supports. Joints in the vertical bus are not permitted.
- .3 Bus bars shall be braced to withstand mechanical forces exerted during short circuit conditions as indicated in drawings, but in no case less than 65KA RMS SYM.
- .4 Bus joints shall be bolted with high tensile steel Grade 5 bolts.
- .5 Ground Bus shall be sized to meet UL 891. Ground bus shall extend full length of switchboard. Ground bus shall be copper.
- .6 A-B-C bus arrangement (left to right, top to bottom, front to rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, bus bars shall be labeled.
- .7 All feeder device line and load connection straps shall be rated to carry current rating of device frame (not trip rating).
- .8 The main incoming bus bars shall be rated for the main protection device frame size or main incoming conductors, if there is no main device.
- .9 Main horizontal bus bars shall be fully rated and arranged for future extensions.

2.4 Enclosures

- .1 Switchboards shall be NEMA 1 c/w sprinkler hood.

2.5 Main Devices

- .1 Main device shall be individually mounted, moulded case circuit breaker. Provide device as specified in appropriate article below.
- .2 Tie device shall be the same as the main device.

2.6 Moulded Case Circuit Breakers

- .1 Group mounted breakers shall be connected to the vertical bus by bolted connections.
- .2 Individually mounted molded case circuit breakers shall be stationary mounted.
- .3 Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
- .4 Breakers shall have ON and OFF position clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

- .5 Breakers shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate. Breakers shall be standard, or 80 percent rated.
- .6 Breakers shall use digital true RMS sensing trip units and a rating plug to determine the breaker trip rating.
- .7 Each main, feeder, and tie breaker shall have digital electronic trip units.

2.7 Digital Electronic Trip Unit For Moulded Case Circuit Breakers

- .1 Each main, feeder and tie circuit breaker shall be equipped with a digital electronic trip unit. The trip unit shall provide protection from overloads, short circuits and ground faults. The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
- .2 The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
- .3 Long time and short time protective functions shall have true RMS sensing technology for harmonic rich currents including up to the 19th harmonic.
- .4 High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.
- .5 A multi-button keypad shall provide local setup and readout of all trip settings on the LCD.
- .6 UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug. Rating plugs shall be available in sizes from 40% to 100% of the breaker sensor rating
- .7 The trip unit shall have an integral test jack for testing via a portable test set and connection to a battery source.
- .8 Noise immunity shall meet the requirements of IEEE C37.90.
- .9 The trip unit shall display trip targets for long time, short time, and ground fault, if included.
- .10 Provide visual illuminated indication of the trip unit (normal, pickup, trip, error).
- .11 The trip unit shall be provided with a ten event trip history log. Each trip event shall be recorded with type, phase and magnitude of fault that caused the trip
- .12 As a minimum, the trip unit shall have the following protective functions:
 - .1 Current setting or long time pickup, adjustable from 50% to 100% of the rating plug value.

- .2 Adjustable long time delay with typical inverse time characteristics (minimum of 10 bands). In addition, a set of straight line fuse shaped long time delay bands shall be provided to facilitate selectivity with downstream fuses (minimum 7 bands).
- .3 Instantaneous pickup, adjustable from 2.0 to 10 times the rating plug in 0.5 increments
- .4 Short time pickup and delay. Short time pickup shall be adjustable from 1.5 to 9 times the long time pickup setting in 0.5 increments with an OFF option. Provide minimum of 12 short time delay bands with three selectable I2t bands.

2.8 Acceptable Manufacturers

- .1 GE
- .2 Schneider
- .3 Eaton's Cutler Hammer
- .4 Siemens

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 switchboard installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 Manufacturer's Instructions

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

3.3 Installation

- .1 As indicated.

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.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA International
 - .1 CSA C22.2 No.29-11, Panelboards and Enclosed Panelboards.

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 panelboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Include on drawings:
 - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

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 panelboards for incorporation into manual.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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, indoors, in dry location 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 208V and 600V panelboards: bus and breakers ratings to be as indicated on single line distribution diagram. All values are indicated in kA IC RMS Symmetrical.
- .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 Sprinklerproof
- .6 Recess mounted in public areas.
- .7 Surface mounted in electrical, mechanical rooms.
- .8 Minimum of 2 flush locks for each panel board.
- .9 Two keys for each panelboard and key panelboards alike.
- .10 Tin plated copper bus with neutral of same ampere rating of mains.
- .11 Mains: suitable for bolt-on breakers.
- .12 Trim with concealed front bolts and hinges.
- .13 Trim and door finish: baked enamel.
- .14 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.

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.
- .4 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Departmental Representative.
- .5 Lock-on devices for fire alarm, emergency and exit circuits.

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 as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.
- .5 Circuits supplying Patient Care Areas must be entered in circuit directory with Bold Font.

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 00 - 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 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.

3.4 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 International
 - .1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CAN/CSA C22.2 No.42.1-00 (R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA C22.2 No.55-M1986 (R2008), Special Use Switches.
 - .4 CSA C22.2 No.11110, General-Use Snap Switches (Bi-national standard, with UL 20).

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 wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

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 wiring devices 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 and 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 wiring devices from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Switches

- .1 20 A, 120 V, single pole switches to: CSA C22.2 No.55.
- .2 Manually-operated general purpose AC switches with following features:

- .1 Terminal holes approved for No. 10 AWG wire.
- .2 Silver alloy contacts.
- .3 Urea or melamine moulding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.
- .5 White paddle.
- .3 Paddle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.
- .5 Acceptable manufacturer's: Leviton, Pass and Seymour, Arrow Hart and Hubbell.

2.2 Receptacles

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
 - .1 White urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 White urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable manufacturer's: Leviton, Pass and Seymour, Arrow Hart and Hubbell.

2.3 Cover Plates

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

2.4 Source Quality Control

- .1 Cover plates from one manufacturer throughout project.

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 wiring devices 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 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - .4 Install GFI type receptacles as indicated.
- .3 Cover plates:
 - .1 Install suitable common cover plates where wiring devices are grouped.
 - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 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.

3.4 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C37.13-2008, Low Voltage AC Power Circuit Breakers Used in Enclosures.
- .2 CSA International
 - .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).

1.3 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 air circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

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 air circuit breakers for incorporation into manual.

1.5 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, in dry location, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air circuit breakers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Air Circuit Breaker

- .1 Air circuit breaker: to CSA C22.2 No.5.
- .2 Draw out type, 600 V class.
 - .1 Continuous current rating: 320 A.
 - .2 Trip rating: 400 A.
 - .3 Interrupting rating: 42 kA, RMS symmetrical.
- .3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Equipped with short, instantaneous, ground fault, long function and phase overload, and ground fault short circuit indication.
- .4 Breakers with motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and isolating switch to isolate power supply to spring charging motor.
- .5 Breakers with on-off indicator and spring charged/discharged indicator.
- .6 Interlocks to prevent circuit breaker drawout when in closed position and to prevent closing unless fully engaged or in test position.
- .7 Current limiting fuses in series and internally mounted up to 2000 A frame size. Interrupting capacity of breaker s to be met without current limiting fuses.
 - .1 Include anti-single-phasing coils which act on tripper bar in parallel with current limiting fuses to prevent single phasing.
 - .2 Co-ordinate time current limiting characteristics of fuses with time current tripping characteristics of circuit breaker.

2.2 Optional Features

- .1 Shunt trip.
- .2 Auxiliary switches: 2 N.O., 2 N.C.
- .3 Undervoltage tripping device with instantaneous.
- .4 Alarm switch.
- .5 Pilot light.
- .6 Reverse power relay.
- .7 Control switch.
- .8 Remote close.
- .9 Lockout devices.
- .10 Padlocking provision.
- .11 Operation counter.

PART 3 EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air circuit breakers 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 air circuit breakers as indicated.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 References

- .1 CSA International
 - .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).

1.3 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 New main circuit breakers and branch breakers to match existing, System Short Circuit withstand rating as shown on power single line drawing.
 - .2 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 Include time-current characteristic curves for breakers with interrupting capacity of 65,000 A symmetrical (rms) and over at system voltage.
- .4 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 by 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.

1.4 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: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store circuit breakers off ground, indoors, in dry location 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 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with Minimum adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 65kA symmetrical rms interrupting capacity rating.

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.

2.3 Magnetic Breakers

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 Optional Features

- .1 Include:
 - .1 Shunt trip.
 - .2 Auxiliary switch.
 - .3 Motor-operated mechanism c/w time delay unit.

- .4 Under-voltage release.
- .5 On-off locking device.
- .6 Handle mechanism.

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 as indicated.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 GENERAL

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 Related Requirements

- .1 This section covers items common to Division 26. This section supplement requirements of Division 1.

1.3 References

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No.4-04(R2009), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMJ-J-162-2004 and UL 98).
 - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

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 disconnect switches - fused and non-fused and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 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: 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, indoors, in dry location 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 Fusible and non-fusible disconnect switch in EEMAC '3R' enclosure for interior sprinkler proof application, unless otherwise indicated.
- .2 Provision for padlocking in on-off position.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as required.

- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

2.3 Approved Manufacturers

- .1 Approved manufacturers: Equipment meeting industry standards.

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 Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 Installation

- .1 Install disconnect switches complete with fuses if applicable.
- .2 Install circuit disconnect switches where indicated or where required by the inspection authorities and/or for equipment supplied by other trades.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

- .1 Provide two (2) 300kW/375kVA standby power systems to supply electrical power at 347/600 Volts, 60 Hertz, 3 Phase, 4 Wire. The generators shall consist of liquid cooled diesel engines, synchronous AC alternators, and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.

- | | | |
|----|---|---------------------|
| .1 | Mechanical Specifications | Section 23 35 00 |
| .2 | Common Work Results - Electrical | Section 26 05 00 |
| .3 | Conduits, Conduit Fastenings and Conduit Fittings | Section 26 05 34 |
| .4 | Wire and Box Connectors | Section 26 05 20 |
| .5 | Connectors and Terminations | Section 26 05 22 |
| .6 | Moulded Case Circuit Breakers | Section 26 28 16.02 |
| .7 | Panelboards | Section 26 24 16.01 |
| .8 | Automatic Transfer Switches | Section 26 36 23 |

- .1 This section covers the supply and installation of the emergency stand-by diesel generator sets and enclosure fully compliant with the enforceable National Building Code of Canada (NBCC).

.1 Refer To Structural Specifications

- .1 Generating system consists of:
 - .1 Diesel engine.
 - .2 Alternator.
 - .3 Alternator control panel.
 - .4 Automatic transfer equipment.
 - .5 Battery charger and battery.
 - .6 Automatic engine and room ventilation system.
 - .7 Fuel supply system.
 - .8 Exhaust system.

- .9 Steel mounting base.
- .10 Synchronizing.
- .11 Manual by-pass switch.
- .12 System designed to operate as emergency stand-by power.
- .13 Prototype & torsionally tested
- .14 UI2200 tested
- .15 Powder paint with 3 mil thickness on steel treated with a five stage wash.
- .16 Fuel tanks
- .17 Skin tight enclosure rated at a maximum of 50dB at 7.0m away.
- .18 Remote annunciator
- .19 Remote mounted master control station
- .20 Generators are to have full paralleling capability via on board equipment. Paralleling switchgear will not be accepted.
- .2 MANUFACTURER QUALIFICATIONS
 - .1 This system shall be supplied by an original equipment manufacturer (OEM) who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of 25 years, thereby identifying one source of supply and responsibility.
 - .2 The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.
 - .3 Manufacturer's authorized service representative shall meet the following criteria:
 - .1 Certified, factory trained, industrial generator technicians
 - .2 Service support 24/7
 - .3 Service location within 200 miles
 - .4 Response time of 4 hours
 - .5 Service & repair parts in-stock at performance level of 95%
 - .6 Offer optional remote monitoring and diagnostic capabilities.

1.6 Shop Drawings

- .1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results.
- .2 Include:
 - .1 Engine: make and model, with performance curves.
 - .2 Alternator: make and model.
 - .3 Voltage regulator: make, model and type.
 - .4 Automatic transfer switch: make, model and type.
 - .5 Manual bypass switch: make and model.
 - .6 Battery: make, type and capacity.
 - .7 Battery charger: make, type and model.
 - .8 Alternator control panel: make and type of meters and controls.
 - .9 Governor type and model.
 - .10 Automatic engine room ventilation system.
 - .11 Cooling air requirements in m3/s.

- .12 British standard or DIN rating of engine.
- .13 Flow diagrams for:
 - .1 Diesel fuel.
 - .2 Cooling air.
- .14 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
- .15 Continuous full load output of set at 0.8PF lagging.
- .16 Description of set operation including:
 - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - .2 Manual starting.
 - .3 Automatic shut down and alarm on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Lube oil high temperature.
 - .8 Over temperature on alternator.
 - .4 Manual remote emergency stop.
- .17 Enclosure construction.
- .18 Alarms and extra contacts.

1.7 Closeout Submittals

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 01002 – General Instructions.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
 - .1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery charger, battery, fuel system, engine room ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair.
 - .2 Technical data:
 - .1 Illustrated parts lists with parts catalogue numbers.
 - .2 Schematic diagram of electrical controls.
 - .3 Flow diagrams for:
 - .1 Fuel system.
 - .2 Lubricating oil.
 - .3 Cooling system.
 - .4 Certified copy of factory test results.
 - .5 Maintenance and overhaul instructions and schedules.

- .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

1.8 Extra Materials

- .1 Provide maintenance materials in turn-over to Departmental Representative..
- .2 Include:
 - .1 2 fuel filter replacement elements.
 - .2 6 lube oil filter replacement elements.
 - .3 2 air cleaner filter elements.
 - .4 2 sets of fuses for control panel.
 - .5 Special tools for unit servicing.
 - .6 Lubricant oil for 2 oil changes.
 - .7 2 sets pilot light lamps.

PART 2 PRODUCTS

2.1 Diesel Engine

- .1 Diesel engine: to ISO 3046-1.
 - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
- .2 Prime mover: full diesel 4 cycle, turbo charge, synchronous speed, 1800 rpm. Engine shall be capable of recovery from 0% to 100% instantaneous step load with maximum transient speed deviation of 10% (6 Hz) and recover to rated speed within 5 seconds.
- .3 EPA Emissions Compliance: Stationary Emergency
- .4 EPA Emissions Reference See Emissions Data Sheet
- .5 Cylinder # 6
- .6 Type: In-Line
- .7 Intake Air Method: Turbocharged/Aftercooled
- .8 Cylinder Head Type: 4 Valve
- .9 Piston Type: Aluminum
- .10 Connecting Rod Type: Drop forged steel
- .11 Capacity:
 - .1 Rated continuous power in kW (300kW) at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation; to be calculated as follows: Rated continuous output = Generator kW divided by Generator efficiency at full load.
 - .1 Under following site conditions:
 - .1 Altitude: 300 ft.
 - .2 Ambient temperature: 30 degrees C.
 - .3 101 KPA barometer pressure.

.12 Cooling System:

- .1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side with ethylene glycol anti-freeze non-sludging above minus 46 degrees C.
- .2 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40 degrees C.
- .3 Block heater: thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch to allow engine to start in room ambient 0 degrees C.
 - .1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.

Fuel System:

- .4 Solid injection, mechanical fuel transfer pump with hand primer, replaceable element fuel filters, fuel rack solenoid energized with engine running, fuel rail line check valve and fuel return line check valve. Fuel system shall be complete with all necessary valves, restrictors, check valves, seals, etc. as required and recommended by the supplier to suit the actual site fuel system. Engine shall operate on Number 2 diesel fuel.
- .5 The fuel tank shall be double wall sub-base tank ('belly tank'), ULC labeled, sized to run generator for a minimum of 36 hours. Tank to include fill port, drain port, vent port, leak detection alarm, overfill protection, fuel level gauge and low fuel level alarm. Fuel for testing purposed shall be included in the contract.

.13 Governor:

- .1 Electronic Isochronous
- .2 Frequency Regulation (Steady State) $\pm 0.25\%$
- .3 Steady state speed band of plus or minus 0.5%.
- .4 Speed regulation no load to full load 5% maximum.
- .5 Electronic load sharing type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.

.14 Lubrication system:

- .1 Pressure lubricated by engine driven pump.
- .2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
- .3 Lube oil cooler.
- .4 Engine sump drain valve.
- .5 Oil level dip-stick.

.15 Starting system:

- .1 The emergency generator system shall be provided with a 24-volt d.c. direct electric starting system suitable for automatic start-stop operation.
- .2 A fully automatic engine start-stop control shall be installed in the generator control panel. Control shall provide for overcrank lockout, pilot lights for low oil pressure, high water temperature, overspeed, overcrank, and a 3-position selector switch marked "Auto"- "Off"- "Manual". Control shall be equipped with timers which provide for 15-second timed cycle cranking consisting of three timed crank periods each followed by a 10-second rest period.

- .3 The engine shall be furnished with an engine mounted thermal circulation type water heater to maintain engine jacket water at 90°F, in an ambient temperature of 50°F. A heater mounted thermostat shall be supplied. Provide engine coolant jacket sensor complete with visual warning alarm.
- .4 Provide a heavy duty starting type lead acid storage battery set consisting of two 12-volt, 4D heavy duty batteries wired in parallel. Battery cables, inter-connectors and steel rack shall also be provided. Battery rack to hold batteries minimum 150 mm (6") above floor surface.
- .5 Provide and install battery charger which shall be a fully automatic type, complete with non-latched battery charger failure alarm.
- .6 The necessary relays to provide the operation as described in clause "Operation" are to be included.
- .16 Vibration isolated engine instrument panel with:
 - .1 Lube oil pressure.
 - .2 Lube oil temperature.
 - .3 Lube oil level.
 - .4 Coolant temperature.
 - .5 Coolant level.
 - .6 Running time meter.
- .17 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .18 Drip pans:
 - .1 Supply and install 25 mm deep galvanized metal drip pans under the engine.
 - .2 These pans shall be sized to fit between the base channels and will be slid under the engine from the generator end when the unit is installed on site.
 - .3 The maximum panel length shall not exceed 1m and if more than one pan is required to cover the required floor space, there must be an overlap on the edge on the pan to prevent oil from dripping between the pans.

2.2 Connectors

- .1 Unit to be complete with flexible connections for fuel, exhaust and ventilation.
- .2 Provide all control wiring.

2.3 Guards

- .1 Provide guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

2.4 Oil Drain

- .1 Extend oil drain valve to make it accessible alongside of the genset engine.

2.5 Alternator

- .1 Alternator: to ANSI/NEMA MG1.

- .2 Output at 40 degrees C ambient:
 - .1 100% full load continuously.
- .3 Revolving field, brushless, single bearing.
- .4 Voltage Regulator Type: Digital
- .5 Poles 4 Number of Sensed Phases: All
- .6 Regulation Accuracy (Steady State): $\pm 1\%$
- .7 Insulation Class – Rotor: H
- .8 Insulation Class – Stator: H
- .9 Total Harmonic Distortion < 5%
- .10 Telephone Interference Factor (TIF) < 50
- .11 Standard Excitation: Permanent Magnent
- .12 Bearings: Single Sealed Cartridge
- .13 Coupling: Direct, Flexible Disc
- .14 Load Capacity - Standby 100%
- .15 Prototype Short Circuit Test: Yes
- .16 Drip proof.
- .17 Amortisseur windings.
- .18 Synchronous type.
- .19 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.
- .20 Exciter: rotating brushless.
- .21 EEMAC class H insulation on windings.
- .22 Voltage regulator: Temperature compensated solid state, silicon controlled rectifiers with phase controlled sensing circuit:
 - .1 Frequency regulation +/- 3% no load to full load.
 - .2 Steady state voltage regulation +/- no load to full load.
- .23 Alternator: capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

2.6 Control Panel

- .1 Provide a unit mounted control console that is factory built, wired, tested and shock-mounted by the unit manufacturer. Control console shall be rigid, 'sprinkler proof', metal enclosure, mounted on the generator end of the set, containing all devices as specified herein, and as required for described functions. Control console shall include a control section and control panel with required access to all components. Control wire shall have termination identification on each wire for ease of tracing. Control wires which run between generator set controls and automatic transfer switches shall have identical termination identification on both ends. Lamacoid nameplates shall be provided to identify each device or function.
- .2 Controls:
 - .1 Engine run-stop-auto switch.
 - .2 Engine emergency stop button plus provision for remote emergency stop button.
 - .3 Lamp test switch and reset switch.
 - .4 Voltage adjusting control.
 - .5 Frequency adjusting control.
 - .6 The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic engine control module (ECM) if so equipped. Generator controller's that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.
 - .7 The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
 - .8 Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.
 - .9 The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions), communications support via RS232, RS485, or an optional modem. Additional I/O must be an available option.
- .3 Automatic shut-down lights and alarms:
 - .1 Engine overcrank (shutdown after 3 cranking attempts).
 - .2 Engine overspeed (shutdown at 115%).
 - .3 High engine temperature (shutdown at 40%).
 - .4 Engine – low lube oil pressure (shutdown at 40%).
 - .5 Short circuit and overcurrent.
 - .6 Low battery voltage continuously monitored even when engine not running. Auto reset alarm.
 - .7 Alternator overvoltage and undervoltage (shutdown at 115% and 85% sustained for 5 seconds).

- .8 Low fuel level (alarm: connect to the building management system and remote annunciator).
- .9 Low coolant temperature (alarm at 20°C to 30°C) (68°F to 86°F).
- .10 Auxiliary contact for "not in auto" (alarm).
- .11 No battery voltage: provide a separate relay audible device and 120V AC power source.
- .12 Common alarm contacts (connect to the building management system and remote annunciator).
- .13 Provide 4 pair cables in conduit to DSC 4020 interface. Engineer will be responsible for terminating cables and all programming. Refer to drawings for conduit sizing.

2.7 Steel Mounting Base

- .1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- .2 Assembly fitted with vibration isolators and control console resiliently mounted.
- .3 Sound insulation pads for installation between isolators and concrete base.

2.8 Exhaust System

- .1 Heavy duty critical horizontally mounted exhaust silencer with condensate drain, plug and flanged couplings.
- .2 Heavy duty flexible exhaust pipe with flanged couplings as required.
- .3 Fittings and accessories as required.
- .4 Expansion joints: carbon steel or stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

2.9 Fuel System

- .1 Fuel storage tanks: to ANSI/API 650, ULC labelled.
 - .1 Base mounted dual wall in-skid fuel tank sized to 36 hours at full load.

2.10 Cooling Air System

- .1 Engine ventilating system:
 - .1 Cold air inlet damper assembly with modulating motor.
 - .2 Air discharge and intake gooseneck weatherhoods.
 - .3 Modulating thermostat.
 - .4 Replaceable air intake filters.

2.11 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 04 - Electrical General Requirements.

2.12 Fabrication

- .1 Shop assemble generating unit including:
 - .1 Base.
 - .2 Engine and radiator.
 - .3 Alternator.
 - .4 Control panel.
 - .5 Battery and charger.
 - .6 Automatic transfer equipment.

2.13 Finishes

- .1 Primed in red oxide rust-resistant coat and factory painted with 2 coats of a good quality machine enamel with colour as directed.
- .2 Alternator control cubicle: paint inside, exterior to match engine and alternator.
- .3 Exhaust and inlet air hoods.
- .4 Other ducts and racks grey.
- .5 Supply 0.25L of grey touch-up enamel.

2.14 Source Quality Control

- .1 Factory test generator set including engine, alternator, control panels and accessories. Submit report to departmental representative.
- .2 Test procedure:
 - .1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
 - .1 Date.
 - .2 Generator set serial no.
 - .3 Engine, make, model, serial no.
 - .4 Alternator, make, model, serial no.
 - .5 Voltage regulator, make and model.
 - .6 Rating of generator set, kW, kV.A, V, A, r/min, Hz.
 - .2 Mark check sheet and record data on forms in duplicate as test proceeds.
- .3 Tests:
 - .1 Tests shall be conducted and certified written report of the tests submitted to the Engineer, tests to include:
 - .1 "A" - Factory Test
 - .1 Standard factory test shall be performed. Submit test information, including ambient temperature (exterior, interior). Test shall be run for minimum six (6) hours with continuous standby rating applied.
 - .2 "B" - On Site Test

- .1 A test run up test of the generating set with the generator control panel controlling its functions and include the simulated power failure conditions to ensure proper operation.
 - .3 Running tests shall be conducted at full load (continuous standby rating) and operated for sufficient time for the engine temperature to stabilize plus additional two (2) hours.
- .2 Additional sound attenuation testing to be performed for both generators/enclosures
 - .1 Factory Test
 - .1 A factory test of the sound levels produced by the generator at full load while in its enclosure are to be performed. This test is to take place outdoors in an open area (similar to a parking lot). Measurements to be taken at every 10° around the unit (360° at 10° intervals for a total of 36 test points). Levels to be taken at 7 meters away from edge of enclosure and at both 1 meter and 2 meters above ground. Test results to be submitted in the form of a report and forwarded to the Departmental Representative for review prior to shipment of the generator. Levels are not to exceed 50dBA at any point.
 - .2 On Site Test
 - .1 A secondary on site test is to be performed once unit is installed and operational. Test to be same as that of the factory. Test results to be submitted in form of a report to the Departmental Representative. Manufacturer to provide modifications/repairs to the unit if the levels exceed the 50dbA requirement.
 - .3 With generator running on "no-load", a block load of not less than 80% of full load shall be applied and voltage and frequency dip recorded and the subsequent recovery time recorded. Voltage regulation shall be recorded.
 - .4 With generator running on not less than 80% of full load, the load shall be disconnected, voltage and frequency variations and the subsequent recovery time recorded.
 - .5 All safety features shall be tested by appropriately simulating the fail condition.
 - .6 Insulation tests shall be conducted on all electrical equipment in accordance with the applicable standards.
 - .7 Loading of generator shall be continuous. (Use all available site loads).
 - .8 All tests shall be performed on site in the presence of the Engineer or his appointed representative and the Generator Manufacturer's representative. NOTIFY the Engineer minimum ONE WEEK PRIOR TO CONDUCTING TESTS.
 - .9 Record test results and submit to the Engineer (record ambient temperatures, etc.).
- .4 Demonstrate:
 - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
 - .2 Operation of manual bypass switch.
 - .3 Automatic shut down of engine on resumption of normal power.
 - .4 That battery charger reverts to high rate charge after cranking.
- .5 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

2.15 Acceptable Manufacturers

- .1 Generac
- .2 Caterpillar
- .3 Kohler

2.16 Skin-Tight Enclosure

- .1 Entire unit to be assembled at the factory and be shipped as a single unit including engine, tank, frame enclosure, exhaust, damper, etc.
- .2 Enclosure to have 2 sets of doors of each side to provide access to all components of the generator. Gutters are to be installed above each door.
- .3 Enclosure to be completely weatherproof and winterized for Manitoba climate.
- .4 The noise rating of the enclosure to be a maximum of 50dB at a distance of 7 meters and 1 meter above ground. This rating to be consistent at 360 degrees around the generators. Noise rating to be measured at full load.
- .5 All exterior hardware to be stainless steel.
- .6 All exposed fasteners are to be stainless steel c/w nylon washers to protect the paint finish.
- .7 Exhaust pipe to include rain guard and rain cap.
- .8 Anti skid adhesive tape on door step.
- .9 Enclosure to include one (1) 125A, 120/240V/1P/3W panelboard c/w main breaker and all required branch circuit breakers.
- .10 Enclosure to include battery charger, space heater, LED interior and exterior lighting, light switch, two (2) 15A outlets, block heater and all associated connections.
- .11 Double walled sub base fuel tank with minimum 36 hours runtime at 100% rated load.
- .12 Final colour of enclosure to be determined during shop drawing phase. Manufacturer to provide paint sample of custom colour options as requested by departmental representative. Manufacturer to allow for entire enclosure to be painted custom colour as selected.

2.17 Accessories

- .1 Remote annunciator displaying the following:
 - .1 Alarms:
 - .1 Overcrank,
 - .2 High engine temperature
 - .3 Low oil pressure
 - .4 Overspeed
 - .5 Emergency stop
 - .6 Low fuel

- .7 Low coolant level
- .8 Low coolant temperature
- .9 Low cranking voltage
- .10 Battery voltage (Hi/Low)
- .11 Battery charger fail
- .12 Common fault
- .2 System status
 - .1 Emergency power system supplying load
 - .2 Not in auto
 - .3 System ready
 - .4 Generator running
 - .5 Communication status
- .2 Communications protocol converter providing Simple Network Management Protocol (SNMP) output from genset. All alarm signals are to be communicated thru this module. Module to be supplied with the generator and installed by the electrical contractor.

PART 3 EXECUTION

3.1 Installation

- .1 Locate generating unit, radiator and all associated equipment and install as indicated.
- .2 Wire and connect all equipment and controls.
- .3 Installation of main fuel tank, pumps and supply, vent and fill lines by Mechanical Contractor. Wire and connection of float controls by Electrical Contractor. Control wiring to be installed in a separate conduit from all power wiring.
- .4 Installation of silencer, exhaust piping and high temperature insulation by Mechanical Contractor. Silencer shall be mounted such that its weight is not supported by the engine.
- .5 Provide branch circuit wiring for block heaters, battery charger, fuel transfer pumps and remote radiator fan.
- .6 Provide all required fuel for testing. Top up fuel tank upon completion of testing.
- .7 Install, wire and connect remote annunciator.
- .8 Installation shall meet the requirements of CSA Standard C282-M89 and CSA Standard B139.
- .9 Coordinate with General contractor to mount the generator set on a 4" (100mm) high concrete housekeeping pad.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 06 - Common Work Results (Testing of Systems) for Electrical.

- .2 Notify Engineer 10 working days in advance of test date.
- .3 Provide fuel for testing and leave full tanks on acceptance.

- .4 Demonstrate:
 - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
 - .2 Unit start and shut down on "Manual" control
 - .3 Unit start and transfer on "Test" control.
 - .4 Unit start on "Engine start" control.
 - .5 Operation of manual bypass switch.
 - .6 Operation of automatic alarms and shut down devices.
- .5 Run unit on load for minimum period of 12 hours to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
- .6 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.
- .7 Fill out Verification Report included.

3.3 Demonstration And Training

- .1 Provide demonstration and training in accordance with Section 26 05 00 – Start-up.

3.4 Operation

- .1 Emergency generator shall start on a signal from either transfer switch, on loss of normal power and transfer the switch.
- .2 Selector switch in Auto position and the normal supply voltage operating, the diesel electric unit is on "automatic service" and shall start and transfer automatically on fire alarm and power failure. Upon return of normal power supply voltage, the generator set will continue to run for a pre-set period for time (5 minutes) and will then automatically return the transfer switch to normal. The engine will continue running for a preset period of time and will then be automatically turned off.
- .3 Selector switch in "MANUAL" position, engine starts and runs up to output until shut off manually. (No transfer takes place).
- .4 Selector switch in "TEST" position, engine starts and system transfer switch, to emergency service. (Simulating power failure as described for Automatic Conditions).

3.5 Warranty

- .1 Provide a 2 year parts and labour warranty from the date of substantial completion for all equipment covered in this section.

VERIFICATION REPORT

EMERGENCY ELECTRICAL POWER SUPPLY FOR BUILDING CSA – C282 – M91 VERIFICATION REPORT

(This form shall be completed by the manufacturer/supplier of the equipment required under the scope of this standard.)

Building Address: _____

Emergency Power System Supplier/Manufacturer:

Company Name: _____

Company Address: _____

Name of the person conducting the test: _____

Telephone: _____ Signature: _____

Date: _____

Generator Data:

_____ KW, _____ V, _____ Phase, _____ Wire

Summary (every line must have the appropriate marking in the space provided).

YES	NO	Emergency Generator is now fully functional in conformance with M282-M91 applicable clauses.
_____	_____	
_____	_____	All relevant features of the suppliers' equipment and respective wiring and installation have been checked and tested in accordance with attached checklist/test record.

EMERGENCY ELECTRICAL POWER SUPPLY

CSA – C282 – M91 – VERIFICATION REPORT
CHECKLIST/TEST RECORD

(Every line must have the appropriate marking in the space provided.)

STATUS		EQUIPMENT, WIRING & INSTALLATION COMPONENTS TO BE CHECKED OR TESTED	CLAUSE NO.
YES	NO		
		Conformances with NFPA Standard 37-1984 "Installation and use of stationary combustion engines and gas turbines".	4.3
		Conformance of installation, wiring, protection and Grounding of the electrical equipment with CSA Standard C22.1, Canadian Electrical Code, Part 1.	4.4
		Conformance with CSA B139-1976 "Installation Code for Oil Burning Equipment".	4.5
		Location of generator set in conformance with the Manitoba Building Code.	5.2
		Vibration	5.6
		Ventilation	5.7
		Temperature	5.8
		Unit equipment for emergency lighting	5.11
		Control sequence	5.12
		Engine horsepower rating	6.1 – 6.2
		Fuel supply	6.4
		Engine control panel	6.5
		Cranking cycle	6.6
		Storage batteries	6.7.1
		Compressed air pressure	6.7.2

Generator construction in conformance with CSA Standard C22.2 #100	7.1
Generator performance	7.2
Exciter	7.4
Voltage regulator	7.5
Voltage build-up	7.6
Overcurrent protection	7.7
Generator controls	7.8
Transfer switch Re: CSA Standard C22.2 No. 178	8.1 – 8.4
Manual by-pass switch	8.5
Initial installation performance test	9.0
Remote Emergency Stop	

Above checklist shall be completed before Letter of Acceptance will be issued for project.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 CSA International
 - .1 CAN/CSA-C813.1-01 (R2006), Performance Test Method for Uninterruptible Power Supplies.
- .2 The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:
 - .1 The UPS shall be UL listed per UL Standard 1778, Fourth edition, Uninterruptible Power Supplies, and shall be CSA Certified.
 - .2 CAN/CSA-C813.1, Performance Test Method for Uninterruptible Power Supplies.
 - .3 The UPS shall be provided with a Short Circuit Withstand Rating (SCWR) label denoting the maximum source fault short circuit current that is applicable to the unit. The withstand rating shall be independently verified by a nationally recognized, third-party lab.
 - .4 The UPS shall withstand input surges to both the rectifier and bypass when configured as either a single input or dual-input unit without damage as per the criteria in EN62040-2 (4kV). The manufacturer shall provide evidence of compliance upon request.
 - .5 The UPS shall comply with FCC Rules and Regulations, Part 15, Subclass B, Class A. This compliance is legally required to prevent interference with adjacent equipment. The UPS shall have a label stating FCC compliance. The manufacturer shall provide evidence and test data of compliance upon request.
 - .6 The UPS shall be compatible with the wiring practices, materials and coding in accordance with the requirements of the Canadian Electrical Code and applicable local codes and standards. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit for top and bottom access to input, output, bypass and DC connections. Connection cabinets shall provide for wiring gutter and wire bend radius as defined by the CEC and CUL.

1.3 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: include information as follows:
 - .1 Catalogue information.
 - .2 Shipping weight.
 - .3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.
 - .4 Description of system operation, referenced to schematic diagram, for:
 - .1 Manual control during initial start-up and load transfer to bypass and back to inverter output.

- .2 Inverter.
- .3 Bypass.
- .5 Estimate with supporting data for Mean Time to Repair factor (MTTR).
- .6 Full load kVA output at unity power factor.
- .7 Efficiency of system at 25%, 50%, 75% and 100% rated load.
- .8 Type of ventilation: natural or forced.
- .9 Battery:
 - .1 Number of batteries.
 - .2 Maximum and minimum voltages.
 - .3 Type of battery.
 - .4 Catalogue data with battery trade name and type.
 - .5 Size and weight of each battery.
 - .6 Battery charge and discharge curves of voltage, current, time and capacity.
 - .7 Derating factor for specified temperature range.
 - .8 Nominal ampere hour capacity of each battery.
 - .9 Maximum short circuit current.
 - .10 Maximum charging current expected for fully discharged condition.
 - .11 Recommended low voltage limit for fully discharged condition.
 - .12 Expected life.
- .10 Inverter:
 - .1 Type and catalogue number.
 - .2 DC current at minimum battery voltage to produce full load AC output.
- .11 Rectifier:
 - .1 Type and capacity, with catalogue number.
 - .2 Battery charging sequence.
 - .3 Current-time data for Silicon Controlled Rectifier (SCR) protective devices.
 - .4 Guaranteed noise level.
 - .5 Estimated life.
 - .6 Metering.
 - .7 Alarms.
- .12 Manufacturer's field experience with UPS of similar ratings including engineering expertise, manufacturing facilities and listing of UPS units manufactured and installed during last 5 years including model, customer, location and installation dates.
- .13 Evaluation of Canadian content.
- .14 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.
- .15 Cooling air required in m³/s.
- .16 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.
- .17 Typical operation and maintenance manual.
- .18 Description of factory test facilities.
- .19 Manufacturer's maintenance capabilities including:

- .1 Willingness to undertake maintenance contract.
 - .2 Number of trained personnel available.
 - .3 Location of trained personnel and repair facilities.
 - .20 Manufacturer's written installation recommendations.
- .3 Shop Drawings:
 - .1 Include outline schematics showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

1.4 Protection Of Systems

- .1 Circuit breakers in system used to isolate it from load and from mains for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during Work on inverter.
- .2 Automatic circuit breakers and protection included in:
 - .1 AC input to rectifier.
 - .2 Battery input.
 - .3 Bypass circuit input.
 - .4 Inverter output.
- .3 Surge suppressors:
 - .1 To protect system against supply voltage switching transients.
 - .2 To protect internal circuits where necessary against voltage transients.
- .4 Current limiting devices, with panel front indication of device operation, to protect inverter SCR's.
- .5 Suitable devices, with panel front indication of device operation, to protect rectifier diodes.
- .6 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

1.5 Quality Assurance

- .1 Submit for approval records, indicating and recording instruments calibration certificates, including meters installed as part of system, in accordance with Section 01 33 00 - Submittal Procedures.

1.6 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for uninterruptible power systems static (UPS) for incorporation into manual.
- .3 Submit interim, draft final, and final Operation and Maintenance (OM) Manual. Final manual approved by Departmental Representative. Submit interim copies before notification of factory test date.
- .4 Operation and Maintenance Manual to include:
 - .1 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operations maintenance and repair.
 - .2 Technical data:
 - .1 Approved shop drawings.

- .2 Characteristic curves for automatic circuit breakers and protective devices.
- .3 Project data.
- .4 Technical description of components.
- .5 Parts lists with names and addresses of suppliers.

1.7 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: Crating:
 - .1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.
 - .2 For rail or sea shipment use double layer of vapour barrier and 19 mm plywood covering.
 - .3 Subassemblies may be packed separately.
 - .4 Label crates:
 - .1 Shipping address.
 - .2 Weight and dimensions.
 - .3 Serial number of unit and brief description of contents.
 - .4 Stencilled with durable paint on at least two sides of each crate.
 - .5 List of contents:
 - .1 In weatherproof envelope stapled on outside of each crate.
 - .2 Copy placed inside each crate.
 - .6 Store materials off ground and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1.8 Warranty

- .1 For the Work of this Section 26 33 53 - Uninterruptible Power Systems Static, 12 months warranty period is extended to 120 months.
- .2 Contractor hereby warrants battery against defects in material and workmanship, but for 10 years. This warranty is for 100% replacement for first three and prorated in equal yearly decreasing increments for remaining 7 years until expiration of warranty at end of 10 years from date of Certificate of Substantial Performance.

1.9 Maintenance Material Submittals

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.1 Design Requirements

The UPS shall be sized to provide a minimum of 112kW/125kVA output (unity load power factor rating). Refer to single line diagram.

The UPS output capacity shall have the option to enable scalability at the time of ordering and shall be upgradeable.

The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to 0.9 leading. The UPS shall also work from unity power factor to 0.5 leading power factors subject to derating.

Load voltage and bypass line voltage shall be 208VAC, three-phase, four-wire plus ground. Input voltage shall be 600VAC, three-phase, three-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service.

The battery shall support the UPS at 100% rated kW load for at least 90 minutes at 77°F (25°C) at startup.

The UPS shall have an active power factor-corrected IGBT converter/rectifier, capable of maintaining input power factor and input current total harmonic distortion (THDi) within specifications without an additional input filter.

The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module. Optional transformers in cabinets or otherwise external to the basic UPS module shall be permissible to provide isolation and/or voltage transformation.

2.2 Components Of The System

.1 Each UPS system shall compose of the following components:

- .1 UPS module including rectifiers and inverters.
- .2 External maintenance bypass cabinet.
- .3 Battery cabinets.
- .4 Static transfer switch

2.3 Design Requirements

- .1 These specifications describe requirements for an Uninterruptible Power System (UPS) optimized for maximum efficiency. The UPS shall automatically maintain AC power to the critical load within specified tolerances and without interruption during failure or deterioration of the normal power source.
- .2 The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions at the site. The UPS shall include all equipment to properly interface the AC power source to the intended load and shall be designed for unattended operation.

2.4 Performance Requirements

- .1 The solid-state power components, magnetics, electronic devices and overcurrent protection devices shall operate within the manufacturer's recommended temperature when the UPS is operating at 100% critical load and maintain battery charging under either of the following conditions:
 - .1 Any altitude within the specified operating range up to 3300 ft. (1000m) elevation
 - .2 Any ambient temperature within the specified operating range of 32°F to 104°F (0°C to 40°C)
- .2 Input
 - .1 Voltage: Input/output voltage specifications of the UPS shall be

- .1 Rectifier AC Input: 208V, three-phase, four-wire-plus-ground
- .2 Bypass AC Input: 208V, three-phase, four-wire-plus-ground
- .3 AC Output: 208V, three-phase, four-wire-plus-ground
- .2 Voltage Range: +20%, -15% at full load
- .3 Frequency Range: 60Hz +/- 10%
- .4 Maximum Inrush Current: UPS inrush current not to exceed 1.5 times rated input current
- .5 Input Current Walk-In: The UPS shall contain a controlled module walk-in to minimize inrush current upon auto-restart. The module walk-in is programmable for a 1 to 5 second delay.
- .6 Power Factor: Minimum 0.99 at full load with nominal input voltage
- .7 Current Distortion: Less than 5% THD at full load input current in double-conversion mode
- .8 Surge Protection: Withstands input surges of 4kV (Line to ground) without damage as per criteria listed in EN 61000-4-5: 1995
- .9 Short Circuit Current Rating: Units shall carry as standard 65kA Short Circuit Withstand Rating. All ratings shall be certified and a label shall be applied to the unit clearly identifying this rating as required by the National Electrical Code.
- .3 AC Output
 - .1 Load Rating: 100% of load rating at 104°F (40°C) for any load from 0.5 lagging to 0.9 leading
 - .2 Voltage Regulation:
 - .1 ±1% RMS average for a balanced, three-phase load
 - .2 ±2% for 100% unbalanced load for line-to-line imbalances
 - .3 Voltage Adjustment Range: ±5% for line drop compensation adjustable by factory service personnel
 - .4 Frequency Regulation:
 - .1 Synchronized to bypass: ±2.0Hz default setting, (adjustable by factory service personnel)
 - .5 System Efficiency (defined as output kW/input kW at rated lagging load power factor; and not less than the values listed below:

kVA Rating	Efficiency (%)			
	25% Load	50%Load	75% Load	100% Load
125	94.21	95.40	95.34	95.08

- .6 Phase Imbalance:
 - .1 Balanced loads 120° ±1°
 - .2 100% unbalanced loads 120° ±2°
- .7 Voltage Transients (average of all three phases):
 - .1 0-100% or 100-0%
 - .2 Response Meets IEC 62040-3: 2010 Figure 2 Curve 1, Class 1
 - .3 Meets ITIC and CBEMA Curve Requirements
 - .4 Transient Voltage Deviation, RMS 5%
 - .5 Recovers within 60 ms

- .8 Overload at Full Output Voltage with $\pm 1\%$ voltage regulation:
 - .1 100% continuously
 - .2 105% - 110% of full load for 60 minutes at 104°F (40°C) ambient
 - .3 110% - 125% of full load for 10 minutes at 104°F (40°C) ambient
 - .4 125% - 150% of full load for 60 seconds at 104°F (40°C) ambient
 - .5 >150% of full load for a minimum of 200 milliseconds at 104°F (40°C) ambient
- .9 Grounding
 - .1 The UPS chassis shall have an equipment ground terminal.

2.5 Modes Of Operation

- .1 The UPS shall operate as an on-line reverse transfer system in the following modes:
 - .1 Normal: The critical AC load shall be continuously powered by the UPS inverter. The rectifier/charger shall derive power from the utility AC source and supply DC power to the DC-DC converter, which in turn shall supply the inverter while simultaneously float charging the battery.
 - .2 ECO Mode: The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality.
 - .3 Battery: Upon failure of utility AC power, the critical load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant via the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
 - .4 Recharge: Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the batteries. This shall be an automatic function and shall cause no interruption to the critical load.
 - .5 Bypass: If the UPS must be taken out of service, the static transfer switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash and in compliance with OSHA requirements.
 - .6 Off-Battery: If the battery only is taken out of service, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker (in the case of external batteries). The UPS shall continue to function and meet all the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

2.6 Fabrication

- .1 Materials
 - .1 All materials of the UPS shall be new, of current manufacture, high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semiconductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat.
- .2 UPS Internal Wiring

- .1 Wiring practices, materials and coding shall be in accordance with the requirements of the Canadian Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the Canadian Electrical Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.
- .3 Field Wiring
 - .1 All field wiring power connections shall be to tin-plated copper busbars for connection integrity. Busbars shall have adequate space to allow two-hole, long-barrel, compression type lugs forming a permanent connection between field wiring and field-installed lugs.
 - .2 Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass and DC connections. In conformance with the CEC, connection cabinets shall provide for adequate wire bend radius.
- .4 Construction and Mounting
 - .1 The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Maximum cabinet height shall be 78.7 in. (2000mm).
 - .2 The UPS shall be NEMA Type 1-compliant, with front doors open to enable safe change of air filters without the need for shutdown.
- .5 Cooling
 - .1 Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings.
 - .2 Temperature sensors shall be provided to monitor the UPS's internal temperature. Upon detection of temperatures in excess of the manufacturer's recommendations, the sensors shall cause audible alarms to be sounded and visual alarms to be displayed on the UPS control panel. Air filters shall be located at the point of air inlet and shall be changeable. No service clearance or ventilation shall be required in the rear of the system.

2.7 Equipment

- .1 UPS System
 - .1 The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and three-phase, transformer-free inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.
 - .2 Surge Protection
 - .1 The UPS shall have built-in protection against surges, sags and overcurrent from the AC source. The protection shall meet the requirements of ANSI C62.41 A3 and B3 including:
 - .1 6kV, 100kHz ring wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground
 - .2 6kV, combined wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground
 - .3 Output Protection

- .1 The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting, current-limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.
- .4 Components
 - .1 Rectifier
 - .1 The term rectifier shall denote the solid-state equipment and controls necessary to convert alternating current to regulated direct current to supply the inverter and charge the battery. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.
- .5 Input Current Harmonic Distortion
 - .1 The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for an additional passive input filter. Input current THD shall be less than 5% at rated load and nominal voltage in double-conversion mode.
- .6 Dynamic Current Input Limit Reduction
 - .1 The rectifier, in conjunction with the other UPS controls and circuitry, shall adjust the current demanded for battery charging as a function of UPS wattage load and input voltage level.
- .7 DC-DC Converter
 - .1 The term DC-DC converter shall denote the equipment and controls to regulate the output of the rectifier to the levels appropriate for charging the battery and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power and, for increased performance, shall be a pulse width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The DC-DC converter shall control charging of the battery. The AC ripple voltage of the charger DC shall not exceed 1% RMS of the float voltage.
- .8 Battery Equalize Charge
 - .1 A manually initiated equalize charge feature shall be provided to apply an equalize voltage to the battery. The duration of equalize charge time shall be adjustable from 8 to 30 hours. A method shall be available to deactivate this feature for valve regulated battery systems.
- .9 Stop Battery Charging Function
 - .1 Battery charging may be stopped by a shunt trip of the battery cabinet breaker when overtemperature is sensed in the battery cabinet, on generator or when environmental contact is closed.
- .10 Overvoltage Protection
 - .1 There shall be DC overvoltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an

uninterrupted load transfer to bypass or shall disconnect the battery via the DC breaker(s) in the battery string.

.11 Temperature-Compensated Charging

- .1 The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. When multiple sensors are used, the voltage shall be based on the average temperature measured. Excessive difference in the temperature measurements shall be reported and the charging voltage adjusted to protect the batteries from excessive current.

.12 Battery Load Testing

- .1 The UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier shall reduce charging voltage to force the batteries to carry the load for a short time. If the curve of battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.

.2 Inverter

- .1 The term inverter shall denote the equipment and controls to convert direct current from the rectifier or battery via the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state, capable of providing rated output power and, for increased performance, the inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). To further enhance reliable performance and efficiency, the inverter shall not require an inverter output series static switch/isolator for the purposes of overload or fault isolation or transfers to bypass.

.2 Overload Capability

- .1 The inverter shall be able to withstand an overload across its output terminals while supplying full rated voltage of up to 150% for 60 seconds. The inverter shall be capable of at least 200% current for short-circuit conditions including phase-to-phase, phase-to-ground and three-phase faults. After the fault is removed, the UPS shall return to normal operation without damage. If the short circuit is sustained, the load shall be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.

.3 Output Frequency

- .1 The inverter shall track the bypass continuously, providing the bypass source maintains a frequency of 60Hz $\pm 1\%$ (0.6 Hz).

.4 Phase-to-Phase Balance

- .1 The inverter shall provide a phase-to-phase voltage displacement of no worse than $\pm 3\%$ with a 100% unbalanced load.

.5 Inverter Fault Sensing and Isolation

- .1 The UPS shall be provided with a means to detect a malfunctioning inverter and isolate it from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits.

.6 Battery Protection

- .1 The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached

the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.

- .7 Inverter Bypass Operation
 - .1 When maintenance is required or when the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC (bypass) source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform a transfer. The inverter bypass circuit shall consist of a continuous duty bypass static switch and an overcurrent protection device to isolate the static bypass switch from the bypass utility source. The bypass static switch shall denote the solid-state device incorporating SCRs (silicon controlled rectifiers) that can automatically and instantaneously connect the alternate AC source to the load.
- .3 Static Bypass Switch Rating
 - .1 The static bypass switch shall be rated for continuous duty operation at full rated load for highest reliability without the use of mechanical devices, such as those used with a momentary rated device.
- .4 Manual Load Transfers
 - .1 A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break, utilizing the inverter and the bypass static switch.
- .5 Automatic Load Transfers
 - .1 An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load to the inverter only after the load has returned to a level within the rating of the inverter source and the alarm has been acknowledged.
- .6 Momentary Overloads
 - .1 In the event of a load current inrush or branch load circuit fault in excess of the inverter rating, the bypass static switch shall connect the alternate AC source to the load for at least 600 milliseconds, allowing up to 1000% of the normal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed before the end of the 600-millisecond period, the bypass static switch shall turn Off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source is to be completed.
- .7 Back-Feed Protection
 - .1 As required by UL1778 and CSA, the static transfer switch shall not back-feed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The purpose of this requirement is to prevent the risk of electrical shock on the distribution system when the normal source of power is disconnected or has failed. If a shorted SCR is detected, the static transfer switch shall be isolated by an internal automatic circuit breaker and

an alarm message shall be annunciated at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the bypass static switch.

.8 Active ECO-Mode

- .1 When selected, this mode of operation shall transfer the load to the bypass source and maintain it there as long as the bypass source frequency, slew rate and voltage are within the adjusted operating parameters. While in this mode, the inverter shall remain operating to be able to instantaneously assume the load without interrupting the output voltage. Should the bypass source go outside the adjusted limits, the bypass static switch shall turn Off, isolating the load from the bypass while the inverter assumes the full critical load. The load shall be transferred from the bypass source to the inverter while maintaining the output voltage within the ITIC and CBEMA curves.

.9 Display and Controls

.1 UPS Control Panel

- .1 The UPS shall be provided with a microprocessor-based control panel for operator interface (may also be referred to as User Interface, or UI) to configure and monitor the UPS. The control panel shall be located on the front of the unit where it can be operated without opening the hinged front door. A backlit, menu-driven, full-graphics, color touchscreen liquid crystal display shall be used to enter setpoints for the battery test (duration and end voltage), display system information, metering information, a one-line diagram of the UPS and battery, active events, event history, startup instructions and transfer and shutdown screens.
- .2 No mechanical push buttons shall be used.

.2 Logic

- .1 UPS system logic and control programming shall reside in a microprocessor-based control system with nonvolatile flash memory. Rectifier, inverter and system control logic shall utilize high-speed digital signal processors (DSPs). CANbus shall be used to communicate between the logic and the User Interface as well as the options. Switches, contacts and relays shall be used only to signal the logic system as to the status of mechanical devices or to signal user control inputs. Customer external signals shall be isolated from the UPS logic by relays or optical isolation.

.3 Metered Values

- .1 A microprocessor shall control the display and memory functions of the monitoring system. All three phases of three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accuracy to $\pm 3\%$ of voltage, $\pm 5\%$ AC current. The following parameters shall be displayed:
 - .1 Input voltage, line-to-line
 - .2 Input current per phase
 - .3 Input frequency
 - .4 Input apparent power (kVA)
 - .5 Battery voltage
 - .6 Battery charging/discharging current
 - .7 Output voltage, line-to-line

- .8 Output frequency
- .9 Bypass input voltage, line-to-line
- .10 Bypass input frequency
- .11 Load current
- .12 Load real power (kW), total and percentage
- .13 Load apparent power (kVA), total and percentage
- .14 Load percentage of capacity
- .15 Battery temperature, each battery string
- .16 Battery state of charge
- .4 Power Flow Indications
 - .1 A power flow diagram shall graphically depict whether the load is being supplied from the inverter, bypass or battery and shall provide, on the same screen, the status of the following components:
 - .1 AC Input Circuit Breaker (optional)
 - .2 Battery Circuit Breaker, each breaker connection of complete battery complement, complete disconnection and partial connection (one or more, but not all breakers open.)
 - .3 Maintenance Bypass Status
- .5 Main Display Screen
 - .1 The following UPS status messages shall be displayed:
 - .1 Rectifier (Off / Soft Start / Main Input On / Battery Input On)
 - .2 Input Supply (Normal Mode / Battery Mode / All Off)
 - .3 Battery Self Test (True / False)
 - .4 Input Disconnect (Open / Closed)
 - .5 EPO (True / False)
 - .6 Charger (On / Off)
 - .7 Output Disconnect (Open / Closed)
 - .8 Maint. Disconnect (Open / Closed)
 - .9 Bypass Disconnect (Open / Closed)
 - .10 Inverter (Off / Soft Start / On)
 - .11 Bypass (Normal / Unable To Trace / Abnormal)
 - .12 Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable)
 - .13 Inverter On (Enable / Disable)
- .6 HMI Control Buttons
 - .1 Buttons shall be provided to start and stop the inverter. A pop-up message requesting confirmation shall be displayed whenever a command is initiated that would change the status of the UPS.
 - .2 Other buttons shall be provided to reset faults and silence the alarm buzzer.
- .7 Event Log
 - .1 This menu item shall display the list of events that have occurred recently while the UPS was in operation. The Event Log shall store up to 2048 events, with the oldest events being overwritten first if the log's capacity is reached.

- .8 Battery Status Indicator
 - .1 A battery status indicator shall display DC alarm conditions, temperature, battery state of charge, the present battery voltage, total discharge time, status of last battery test and battery time remaining during discharge.
 - .2 The UPS shall provide the operator with controls to perform the following functions:
 - .1 Configure and manage manual battery test
 - .2 Modify test duration and minimum voltage
 - .3 Start battery test
 - .4 Monitor test status and progression
 - .5 Stop battery test
 - .6 Battery test status
- .9 Alarms
 - .1 The following alarm messages shall be displayed:
 - .1 Mains Voltage Abnormal
 - .2 Mains Undervoltage
 - .3 Mains Freq. Abnormal
 - .4 Charger Fault
 - .5 Battery Reversed
 - .6 No Battery
 - .7 Parallel Comm. Fail
 - .8 Bypass Unable To Track
 - .9 Bypass Abnormal
 - .10 Inverter Asynchronous
 - .11 Fan Fault
 - .12 Control Power Fail
 - .13 Unit Over Load
 - .14 System Over Load
 - .15 Bypass Phase Reversed
 - .16 Transfer Time-Out
 - .17 Load Sharing Fault
 - .18 Bypass Over Current.
- .10 Controls
 - .1 System-level control functions shall be:
 - .1 Start Inverter (and transfer to inverter)
 - .2 Stop Inverter (after transferring to bypass)
 - .3 Startup Screen
 - .4 Battery Test Setpoint Adjustment
 - .5 Configure Manual Battery Test
 - .6 Initiate Manual Battery Test
 - .7 System Settings (Time, Date, Language, LCD Brightness, Password, Audio Level)
 - .8 Alarm Silence Command
 - .9 Fault Reset Command

- .10 ECO mode
 - .11 Manual Procedures
 - .1 Load Transfers: HMI buttons (START INVERTER, STOP INVERTER) shall provide the means for the user to transfer the load to bypass and back on UPS.
 - .12 Self-Diagnostics
 - .1 Event Log File - The control system shall maintain a log of the event conditions that have occurred during system operation. Each log shall contain the event name, event time/date stamp and a set/clear indicator.
- .10 Remote Monitoring and Integration Capabilities
 - .1 Communication Cards:
 - .1 Communications card to be provided integral to the UPS with the following communications protocols:
 - .1 SNMP protocols (v1, v2, v3)
 - .2 Modbus RTU or Modbus TCP
 - .3 BACnet MSTP or BACnet IP
- .11 Output Alarm Contacts:
 - .1 Dry contact outputs shall be provided for Summary Alarm, Bypass Active, Low Battery and AC Input Failure.
- .12 Customer Input Contacts:
 - .1 The UPS shall have four discrete input contacts available for the input and display of customer-provided alarm points or to initiate a pre-assigned UPS operation. Each input can be signaled by an isolated, external, normally open contact.
 - .2 When an assembly is selected as a pre-assigned UPS operation, the following actions shall be initiated:
 - .1 On Generator—Provides selectable choices to enable or disable battery charging, and enable or disable ECO Mode operation while on generator.
 - .2 Transfer to Bypass—Manual command to transfer from inverter operation to static bypass operation.
 - .3 Fast Power Off—Emergency Module Off (EPO) command to stop UPS operation.
 - .4 Acknowledge Fault—Acknowledge a UPS alarm condition and present faults will be reset.
 - .5 Bypass/Inverter Off—Emergency Power Off (EPO) command to stop UPS operation.
 - .6 External Maintenance Bypass Breaker (MBB) status (open or closed)
- .13 Battery Disconnect Breaker
 - .1 The battery cabinet shall have a properly rated circuit breaker (600VDC) to isolate it from the UPS. This breaker shall be in a separate NEMA-1 enclosure or in a matching battery cabinet. When this breaker is open, there shall be no battery voltage in the UPS enclosure. The UPS shall be automatically disconnected from the battery by a shunt trip of the battery cabinet breaker when signaled by other control functions.

2.8 Enclosures

- .1 All UPS equipment to be mounted in NEMA 1 type enclosures c/w sprinkler hoods. Finish of hood to match that of enclosures.

2.9 Acceptable Manufacturers

- .1 GE
- .2 Schneider APC
- .3 Eaton's Powerware

2.10 Static Transfer Switch

- .1 The Static Transfer Switch shall be a three-pole, double-throw, solid-state, automatic transfer switch that is fed from two AC power sources. One source shall be designated as the preferred source, while the other is the alternate source. Selection of which input source is preferred shall be user selectable from the operator control panel. All transfers shall be a fast break-before-make with no overlap in conduction from one source to the other. All transfers, including sense and transfer times, shall have typically less than a 1/4 cycle interruption in power to the load.
- .2 The Static Transfer Switch is fuseless and consists of six pairs of Silicon Controlled Rectifiers (SCRs) connected in an AC switch configuration. The SCRs are continuous rated to carry 100% of the Static Transfer Switch rated load while operating within the Static Transfer Switch specifications. The use of fuses for protection is not permitted due to possible fuse clearing in an out of phase transfer.
- .3 The Static Transfer Switch logic power shall automatically power up when connected to the power source. The control panel shall be active as long as one input to the Static Transfer Switch is energized. The Static Transfer Switch shall be supplied with factory default settings; mechanical trim pots shall not be used for calibration or adjusting settings. All settings must be adjustable; the settings shall be adjusted/configured from the LCD display.
 - .1 Normal Mode. The unit is fed by two sources with the output connected to the load. In normal operation, the load shall be connected to the preferred source as long as all phases of the preferred source are within the acceptable limits. The transfer voltage limits shall default to $\pm 10\%$ of the nominal input voltage for steady state conditions, with low voltage transfer limits having an inverse time relationship that is within the IEEE Std. 446 computer voltage tolerance envelope. Upon failure of the preferred source, the load shall be transferred to the alternate source. After the preferred source returns to within the acceptable voltage limits for at least the preset adjustable retransfer time delay (typically 3 seconds) and is in phase with the alternate source, the load shall be retransferred automatically to the preferred source. The automatic retransfer to the preferred source can be disabled if so selected by the user from the operator control panel. When the automatic retransfer is disabled, emergency transfers from the alternate source to the preferred source shall not be disabled upon alternate source failure.
 - .2 Load Current Inhibit (also called I_{peak} or Peak Current Overload). The Static Transfer Switch shall sense the load current and, if the load current exceeds an adjustable preset level deemed to represent a load inrush or fault condition, the Static Transfer Switch shall disable the automatic transfer even if the voltage on the selected source exceeds the transfer limits. The load current transfer inhibit shall be (automatically) (manually) reset after the current returns to normal to allow for continued protection against a source failure.

- .3 Manual Transfer. The Static Transfer Switch shall allow manually initiated transfers between the two sources, providing the alternate source is within acceptable voltage limits and phase tolerances with the preferred source. Allowable phase differences between the sources for manually initiated transfers shall be adjustable from the operator control panel. The Static Transfer Switch shall be capable of tolerating transfers up to 180 degrees out of phase for emergency conditions. The user-adjustable phase synchronization window shall be limited to ± 30 degrees, without the Optimized Transfer option. With the Optimized Transfer option installed, the user-adjustable phase synchronization window will be ± 180 degrees. If the transfer is manually initiated, the Static Transfer Switch shall transfer between the two sources without interruption of power to the load greater than 1 millisecond provided that both sources are available and synchronized within the user-adjustable phase synchronization window. For sources where the two frequencies are not exactly the same (as would be the case between a utility and standby generator source), manually initiated transfers shall be delayed by the Static Transfer Switch until the two sources are within the user-adjustable phase synchronization window.
- .4 Emergency Transfer. In an effort to maintain power to the load, upon loss of the source that the load is connected to, the Static Transfer Switch shall automatically transfer to the other source in less than 1/4 cycle, overriding any retransfer time delays or other inhibits except load overcurrent providing that the other source is available. If one source is shorted upstream, causing an undervoltage condition on that source, the Static Transfer Switch will sense the undervoltage and transfer to the alternate source.
- .5 SCR Failure. The Static Transfer Switch shall continuously monitor the status of the SCR switching devices for proper operation. In the event of a shorted SCR on the source powering the load, the Static Transfer Switch shall automatically alarm the condition and trip open the other source isolation MCS. In the event of a shorted SCR on the other source, the Static Transfer Switch shall automatically alarm the condition and trip open the other source isolation MCS. In the event of an open SCR, the switch shall automatically alarm the condition and transfer to the other source. All open and shorted SCR alarm conditions shall be latched and require the system to be repaired and reset to restore normal operation.
- .6 System Bypass. The Static Transfer Switch shall be furnished with key-interlocked maintenance bypass MCSs that allow the Static Transfer Switch power, controls and monitoring electronics to be bypassed to either input source for maintenance without interruption of power to the load. The packaging of the Static Transfer Switch shall have all electronics isolated from the input, output and bypass connections to allow servicing of any components without access to hazardous voltages when the unit is in maintenance bypass.

2.11 Performance Requirements

- .1 Nominal Input/Output Voltage: 208 volts three phase, 4-wire-plus-ground
- .2 Default Voltage Range: +10%, -10% of nominal
- .3 Nominal Frequency: 60 Hz
- .4 Maximum Continuous Current: 400 amps
- .5 Source Voltage Distortion: Up to 10% THD with notches and ringing transients
- .6 Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41 Category B3
- .7 Sensing and Transfer Time: typically less than 1/4 cycle

- .8 Overload Capability: 125% for 30 minutes (100-400A), 150% for 2 minutes, 500% for 0.25 seconds
- .9 Short Circuit Withstand Capability: 65kA at 208VAC.

2.12 Reliability

- .1 MTBF
 - .1 The Static Transfer Switch shall be designed for high reliability and high availability with an MTBF exceeding 1,000,000 hours. To the fullest extent practical, redundant circuits and components shall be used to eliminate single points of failure.
- .2 Power Supply
 - .1 Redundant power supplies shall be provided to prevent any single-point power supply failure mode. The Static Transfer Switch shall have two completely separate power supplies mounted on separate boards so a power supply can be replaced while the load is on bypass. There shall be two separate DC buses, one from each power supply, to provide redundancy throughout the controls.
- .3 Logic
 - .1 Control logic shall be triple-redundant. Each of the three logic modules shall have its own separate power connection to each power supply bus. Each logic module shall be fused to prevent it from shorting the power supplies if an internal failure occurs. Gating and control logic shall be partitioned so that the failure of one source's gating or sensing logic does not prevent the switch from transferring to the other source.

2.13 Components

- .1 All electrical components requiring normal maintenance or repair shall be replaceable without de-energizing the load, assuming that at least one source is available. Solid-state switching devices shall be packaged to allow safe repair of the switching devices without having to de-energize the load. All MCSs shall be of a plug-in or draw-out type to allow replacement without de-energizing the load. All control and logic components shall be mounted separate from the power components.
- .2 Fuseless
 - .1 No fuses are used to protect the solid-state power switching devices.
- .3 Access
 - .1 The Static Transfer Switch shall be designed for front access only. The Static Transfer Switch shall be designed so all installation, repairs and maintenance can be done from the front or top of the unit. The Static Transfer Switch shall be designed to minimize the exposure of hazardous voltages to allow safe servicing of the unit while the load is energized. Barriers shall be used on and around customer connections to protect personnel during maintenance.

PART 3 PRODUCT

3.1 Materials

- .1 All materials of the Static Transfer Switch shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
- .2 The maximum working voltage, current and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component subassembly shall not be greater than 75% of their ratings.

3.2 Wiring

- .1 Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70). All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections are to be torqued to the required value and marked with a visual indicator.
- .2 Provision shall be made for power and control cables to enter or leave from the top or bottom of the Static Transfer Switch cabinet.

3.3 Frame And Enclosure

- .1 The Static Transfer Switch unit, comprised of solid-state, three-pole, dual-position transfer switch, key-interlocked static switch isolation and bypass MCSs, shall be housed in a single free-standing NEMA type 1 enclosure c/w sprinkler hood. The frame shall be constructed of galvanized steel and pop riveted to provide a strong substructure. The frame shall include four heavy-duty swivel castors for ease of installation and four permanent leveling feet for final installation. Doors and removable exterior panels shall be a minimum of 16GA steel and be powder-painted the manufacturer's standard color textured enamel finish paint. A key-lock, hinged front door shall provide access to the MCSs. A tool shall be required to remove exterior panels that expose hazardous voltages. All removable panels shall be grounded to the frame for safety and EMI/RFI protection. The cabinet shall be structurally designed to handle forklifting from the base.
- .2 Removable conduit/cable termination plates shall be provided in the top and bottom of the unit for termination of the two source input and/or output conduits, raceways or cables.
- .3 The Static Transfer Switch can be tipped 15 degrees in any direction without falling over.

3.4 Cooling (100-600A)

- .1 The Static Transfer Switch shall utilize convection air cooling for the enclosure with forced air cooling of the heat sinks. All fans shall be redundant so that a single fan failure will not cause temperature to increase beyond acceptable limits. Individual sensor(s) are located on heat sinks for alarm and shutdown. Heat rejection shall be through screened protective openings in the top of the unit. Air filters shall be located in the front door at the point of air inlet.

3.5 Grounding

- .1 The Static Transfer Switch shall operate from sources that are solidly grounded or impedance-grounded (for 480V and below). The unit shall not be used on corner-grounded delta systems.
- .2 The AC output neutral shall be electrically isolated from the Static Transfer Switch chassis. The Static Transfer Switch chassis shall have an equipment ground terminal.

3.6 Components

3.7 Molded-Case Breaker (Mcb)

- .1 The Static Transfer Switch shall be equipped with six MCBs. The MCBs shall be UL listed and IEC rated for use at the system voltage. The plug-in feature of the breaker shall include interlock, which prevents the breaker from being unplugged without being in the Off (open) position. Three of the MCBs shall provide for total isolation of the solid-state switching devices with an input MCB for each source and a load isolation MCB. Two of the MCBs shall provide for maintenance bypassing of the solid-state switching devices to either input source. Key interlocks shall be provided on the MCBs to prevent improper maintenance bypassing of the solid-state switch. A bypass MCB cannot be closed unless the solid-state switch is connected to the same input source, and only one bypass MCB can be closed at a time. All MCBs shall be equipped with N.O. and N.C. auxiliary switches for monitoring of the breaker positions. The two input MCBs for the solid-state switching devices also shall be equipped with 48 VDC shunt trips to allow for control by the Static Transfer Switch logic.

3.8 Silicon Controlled Rectifiers (Scrs)

- .1 The Static Transfer Switch consist of six pairs of SCRs connected in an AC switch configuration. The SCRs shall be brick-type and rated to carry the full 100% rated load. The SCRs shall be rated to prevent hazardous device failure in power systems with available fault currents.

3.9 Control Panel

- .1 The Static Transfer Switch shall be provided with a microprocessor-based Human-Machine Interface (HMI) to configure and monitor the Static Transfer Switch. The HMI shall be located on the front of the unit and can be operated without opening the hinged front door. The HMI shall not be mounted to the front door so the door can be easily removed for maintenance. A backlit, menu-driven, full graphics, color touch-screen Liquid Crystal Display (LCD) shall be used to display system information, status information, a one-line diagram of the Static Transfer Switch, active alarms, alarm history information, startup and bypass instructions. No mechanical pushbuttons shall be used.
- .2 The mimic screen shall indicate the power flow, the status of all MCSs, the preferred source and the Static Transfer Switch position (connected to source 1 or 2) as well as active alarms.
- .3 Pop-up boxes selected from the menu bar shall be provided for operator interface to the HMI for menu selection, control of the preferred source, manual transfer initiation, auto/manual retransfer selection and other system setpoints. In addition, an operator can silence and reset the audible alarm by touching the screen. To facilitate STS operation, help text, step-by-step startup, transfer and maintenance bypass procedures shall be displayed on the LCD screen. For manual transfers, a syncscope shall display the leading or lagging real-time phase difference between the two input sources.
- .4 The HMI shall be equipped with an internal RS232 port and Flash memory to allow the Static Transfer Switch software to be upgraded by a factory-trained customer engineer without shutting down the load.
- .5 To facilitate diagnostics, an event log of the last 512 alarm events shall be stored in non-volatile memory and displayed on the LCD. Two history logs, each having 64 frames of unit status frozen upon an alarm condition designated as a freeze fault, will be stored in non-volatile memory and displayable on the LCD. A frame shall be acquired every 4 milliseconds, with 40 frames before the fault and 23 frames after the fault. Each frame contains metering data, active alarms/faults and unit status. A system calendar and real-time clock shall be included to time-stamp all stored events. Monitored parameters shall be acquired two times per 4-millisecond frame.
- .6 CAN bus shall be used to communicate between the logic and the HMI as well as the options.

- .7 For remote monitoring, a serial RS-232 port shall provide present switch status information, alarm history information and the history of status screens that are triggered upon a major alarm event.

3.10 Metering

- .1 The following metering parameters shall be displayed:
- .1 Input AC voltage for both sources, line-to-line for each phase
 - .2 Input AC current for both sources for each phase
 - .3 Input frequency for both sources
 - .4 Output kVA
 - .5 Output kW
 - .6 Percent load
 - .7 Number of switch transfers
 - .8 Synchronization phase angle
- .2 All voltages and currents shall be measured using true-RMS techniques for accurate representation of non-sinusoidal waveforms associated with computers and other electronic loads. The metering parameters shall have a full-scale accuracy of $\pm 2\%$.

3.11 Alarm Messages

- .1 Active alarms shall be monitored and displayed simultaneously as part of the LCD event panel. The following alarm messages shall be displayed:

Source 1 Failure	CB1 (Source 1) Open	Power Supply S1 AC Failed
Source 2 Failure	CB2 (Source 2) Open	Power Supply S2 AC Failed
Sources Out of Sync	CB3 (Output) Open	Power Supply DC A Failed
Source 1 Overvoltage	CB3A Open (If used)	Power Supply DC B Failed
S1 Undervoltage (fast)	CB4 (S1 Bypass) Closed	Power Supply Logic Failed
S1 Undervoltage RMS (slow)	CB5 (S2 Bypass) Closed	S1 Voltage sense module failed
Source 2 Overvoltage	CB1 Shunt trip fail	S2 Voltage sense module failed
S2 Undervoltage (fast)	CB2 Shunt trip fail	S1 SCR sense module failed
S2 Undervoltage RMS (slow)	S1 SCR Open	S2 SCR sense module failed
Source 1 Overcurrent	S2 SCR Open	S1 Current sense module failed
Source 2 Overcurrent	S1 SCR Shorted	S2 Current sense module failed
Source 1 Over/Under Frequency	S2 SCR Shorted	S1 Gate drive module failed
Source 2 Over/Under Frequency	Primary fan failure	S2 Gate drive module failed
Source 1 Phase Rotation Error	Control Module Fail	Internal comm failed
Source 2 Phase Rotation Error	S1 I-peak	Option comm failed
Output undervoltage	S2 I-peak	Output voltage sense module failed
STS on alternate source	Auto Retransfer Inhibit	Heatsink Overtemp
Transfer Inhibit		

- .2 An audible alarm shall be activated when any of the alarms occurs. All alarms shall be displayed in text form.

3.12 Accessories (Optional Components And Services)

- .1 Optimized Transfer
- .2 The Static Transfer Switch shall be furnished with an optimized transfer control algorithm. This algorithm shall optimize the Static Transfer Switch transfer timing such that the volt-seconds applied to a downstream transformer(s) primary is balanced, thus sufficiently minimizing peak saturation current drawn by the downstream transformer(s).
- .3 In addition to controlling the transformer primary current and flux, the optimized transfer control algorithm must maintain the load voltage within the CBME/ITIC Standards during the transfer. To maintain load voltage after the preferred source is turned off, the control algorithm must be able to pulse-fire the alternate source SCRs to minimize load discontinuity and voltage disruption.
- .4 The Static Transfer Switch must maintain the above specification under the following conditions:
 - .1 Loss of source
 - .2 Loss of a single phase
 - .3 Voltage droop
 - .4 Phase-to-neutral short
 - .5 Phase-to-phase short
 - .6 Power factor load range of 0.75 to 1.0 leading or lagging
 - .7 Out-of-phase conditions from +180° to -180°
- .5 Programmable Relay Board
 - .1 A Programmable Relay Board with eight sets of isolated Form C contacts shall be provided to indicate a change of status of any alarm condition. Any alarm can be programmed onto any channel or channels. Up to two programmable relay boards can be installed in the Static Transfer Switch. Programming is performed through the touch screen display. Each contact shall be rated 1A @ 30 VDC or 250mA @ 125 VAC.
- .6 Input Contact Isolator Board
 - .1 An Input Contact Isolator Board with eight relay inputs (normally open dry contacts) shall be provided for owner alarm messages. The owner, through the touch screen display, can program the alarm messages.
- .7 Communications Card
 - .1 Communications card to be provided integral to the STS with the following communications protocols:
 - .1 SNMP protocols (v1, v2, v3)
 - .2 Modbus RTU or Modbus TCP
 - .3 BACnet MSTP or BACnet IP
- .8 Remote Source Selection
 - .1 The Static Transfer Switch shall be furnished with Remote Source Selection board to remotely select the preferred source. Closure of one of the two N.O. dry contacts (by others) shall cause the selected source to be the preferred source to which the Static Transfer Switch will connect the load as long as the source is available in the same manner as the local source transfer selection. If both input contacts are closed, the current selected preferred source shall be retained. If the unit preferred source selection and remote source selection shall be active at the same time, the Static Transfer Switch follows the last request for a preferred

source change, regardless of whether it was from the local or remote source select controls.

.9 Key Lockout Switch

- .1 A key lockout switch shall be provided which activates a software lockout of the touch-screen display to prevent manual transfers and configuration changes. When locked out, the touch screen becomes a read-only display and a key is required to do manual transfers or change settings. The alarm silence button shall not be disabled when in the lockout position. The switch shall be located behind the front door but can be operated without opening the front door.

3.13 Equipment Identification

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 For major components such as AC input breaker, inverter breakers, bypass switch: size 5 nameplates.
- .3 For mode lights, alarms, meters: size 3 nameplates.

3.14 Source Quality Control

- .1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery factory tested in presence of Departmental Representative.
- .2 Notify Departmental Representative:
 - .1 One week in advance of date of factory test.
 - .2 That system has had preliminary testing and has met design requirements satisfactorily.
- .3 Test procedures:
 - .1 Prepare blank forms and check sheet with spaces for recording data.
 - .2 Mark check sheet and record test data on forms in duplicate as test proceeds. Attach meter recordings.
 - .3 Collect Departmental Representative's signature on form to indicate concurrence in results reported.
 - .4 Deliver duplicate of test results to Departmental Representative at end of test.
 - .5 Include information from original test as part of Operations and Maintenance Manual.
- .4 Test equipment:
 - .1 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate.
 - .2 Dummy load for testing, adjustable to 150 % of system rated output at 0.8 power factor lagging. Load on each phase adjustable from zero to 100% so that unbalanced output maybe tested for 3 phase systems.
- .5 Tests:
 - .1 Visual inspection to determine:
 - .1 Materials, workmanship, and assembly conform with design requirements.
 - .2 Parts are new and free of defects.
 - .3 Battery and components are not damaged.

- .4 Battery cells are of identical construction.
- .5 Electrolyte in each cell is at manufacturer's recommended full level.
- .6 Each battery cell polarity and polarity of connections to inverter are correct.
- .7 Proper size fuses are installed.
- .8 Metres have suitable range.
- .9 Accessories are present.
- .10 Portable metres for acceptance tests are suitable and instrument transformers connected correctly.
- .2 Demonstrate:
 - .1 System start-up and shut down.
 - .2 Operation during mains power failure, recording output during failure and return of mains power, using oscilloscope and camera attachment. Repeat several times.
 - .3 Adjustable settings.
 - .4 Record values measured at test points using oscilloscope, digital multimeter, visicorder and camera attachment.
 - .5 Protective devices and indications function as designed. Record actual settings, and note operation of remote indications and transfer to bypass. Tests to include:
 - .1 Annunciator lights correct indication.
 - .2 Overcurrent on inverter output.
 - .3 Over voltage and under voltage of inverter output.
 - .4 DC input voltage to inverter too low. Gradually reduce DC input voltage to inverter while delivering full load output and load to transfer automatically to bypass and inverter shut down. Record input and output values.
 - .6 Simulate over temperature by applying heat to sensor with hot air blower.
 - .7 Simulate fuse blowing to test indication response.
 - .8 Simulate fan failure.
 - .9 Bypass switch automatic operations. Record with camera/oscilloscope absence of load disturbance during automatic bypass switching.
 - .10 Over voltage of rectifier DC output.
- .3 Harmonic test:
 - .1 With system fully loaded, one-half loaded, and at no load, determine total harmonic content with harmonic distortion metre at output terminals.
 - .2 Determine each harmonic magnitude with harmonic wave analyzer.
 - .3 Measure phase to neutral at 0.8 lagging power factor.
- .4 Transients:
 - .1 With normal power input, apply full load to system.
 - .2 Remove one half load from each phase.
 - .3 Reapply one half load instantly.
 - .4 Record voltages and currents using oscilloscopes.
- .5 Steady load:
 - .1 Switch system onto AC mains, start inverter and connect dummy 0.8 power factor load.

- .2 Operate each module system at full rated load for 24 hours and at 125% load for 10 minutes in ambient temperature of 40 degrees C.
- .3 Record data at start of test and at half hour intervals thereafter; including:
 - .1 Input frequency.
 - .2 Input voltage each phase.
 - .3 Input current each phase.
 - .4 Input kW.
 - .5 Output voltage phase to phase, phase to neutral.
 - .6 Output current each phase.
 - .7 Output kW.
 - .8 Temperature of ventilating air-in.
 - .9 Temperature of ventilating air-out.
 - .10 Temperature at critical zones.
 - .11 DC voltage to inverter.
 - .12 DC current to inverter.
 - .13 Rectifier DC current.
- .6 Varying loads:
 - .1 Take one set of readings as above of no load, 25% load, 50% load, 75% load and 125% load.
 - .2 Calculate efficiencies of rectifier, inverter, and complete system.
- .7 Unbalanced loads:
 - .1 Adjust loads on inverter to full load on two phases, 80% load on third phase.
 - .2 Adjust loads on inverter to zero load on two phases, 20% load on third phase.
 - .3 For both cases, record phase and line voltages and currents with phase angles to prove that phase relation remains unchanged with unbalanced loads.
- .8 Battery:
 - .1 Charge battery to ensure cells fully charged. When voltage reaches steady value at end of charge, record:
 - .1 Ambient temperature.
 - .2 Temperature of each cell.
 - .3 Voltage of each cell.
 - .4 Voltage of battery.
 - .5 Charging current.
 - .6 Specific gravity of each cell (lead acid battery only).
 - .2 Discharge battery by operating uninterruptible power system with AC mains open, at full rated output for duration quoted in design requirements. Record, at 5 minutes intervals:
 - .1 Voltage of battery.
 - .2 Current.
 - .3 Voltage of 10% random cells.
 - .4 Ambient temperature.
 - .5 Battery temperature.

- .6 Specific gravity of 10% random cells (lead acid only).
- .3 Recharge battery automatically by closing AC mains supply to system for 4 hours period, with dummy load connected. Record at 15 minutes intervals.
 - .1 Battery voltage.
 - .2 Charging current.
- .4 At start and finish of charge record ambient and battery temperatures, and specific gravity of each cell (lead acid only).
- .5 Repeat discharge test and readings to prove battery was at least 95% recharged in 4 hours charge period.
- .6 Recharge battery.
- .9 Operating sound level:
 - .1 Operator to take reading by placing metre in front of him with microphone pointed at right angles to path of travel of generated sound, positioned at height of 1.5 m and distance of 1 m from equipment to be tested.
 - .2 Measure sound level during low ambient sound level.

PART 4 EXECUTION

4.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for uninterruptible power systems static (UPS) 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.

4.2 Installation

- .1 Locate UPS cubicles, battery rack and battery as indicated.
- .2 Locate and install remote mode lights and alarm cabinets as indicated.
- .3 Assemble and interconnect components to provide complete UPS as specified.
- .4 Connect AC mains to main input terminal.
- .5 Connect UPS output to load.
- .6 Start-up UPS and make preliminary tests to ensure satisfactory performance.

4.3 Testing

- .1 Perform tests in accordance with Section CAN/CSA-C813.1, 26 05 00 - Common Work Results for Electrical.
- .2 Provide:
 - .1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.

- .2 Dummy load adjustable to 150% of system rated output.
- .3 Notify Departmental Representative 10 working days in advance of test date.
- .4 Tests:
 - .1 Inspection of cubicles, battery rack and battery.
 - .2 Inspection of electrical connections.
 - .3 Inspection of installation of remote mode lights and alarms.
 - .4 Demonstration of system start-up and shut-down.
 - .5 Run UPS for minimum period of 4 hours at full rated load to demonstrate proper operation with AC mains input, emergency generator input, no AC input.
 - .6 Discharge battery by operating UPS with AC mains open for specified duration of full load. Record readings of temperature of each cell.
 - .7 Recharge battery automatically with full rated load on UPS for 4 hours and record readings of voltage of each cell.

4.4 Start-Up

- .1 Arrange with Departmental Representative :
 - .1 For factory service engineer to supervise start-up of system, checking, adjusting and testing on site.
 - .2 For instruction of required personnel on theory, construction, installation, operation and maintenance of system:
 - .1 After installation and during site testing.
 - .2 At factory during shop testing.
- .2 Advise on:
 - .1 Expected failure rate of equipment.
 - .2 Type of expected failures.
 - .3 Estimated time between major overhauls based on 20 year equipment life.
 - .4 Estimated cost of major overhaul based on current costs and excluding travelling expenses.
 - .5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

4.5 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

4.6 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by UPS installation.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 CSA International
 - .1 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
 - .2 CSA C22.2 No.178.1-2007, Automatic Transfer Switches.
 - .3 CAN/CSA C60044-1-07, Instrument Transformers.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 2-1996 (R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

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 transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Make, model and type.
 - .2 Single line diagram showing controls and relays.
 - .3 Description of equipment operation including:
 - .1 Automatic starting and transfer to standby unit and back to normal power.
 - .2 Test control.
 - .3 Manual control.
 - .4 Automatic shutdown.

1.4 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
 - .1 Schematic diagram of components, controls and relays.

- .2 Illustrated parts lists with parts catalogue numbers.
- .3 Certified copy of factory test results.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location, off ground, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 System Description

2.2 Equipment Identification

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.3 Ratings

- .1 The transfer switches shall have a 3 cycle withstand and closing rating of 42 kA min at 600 volts.
- .2 The transfer switch shall be 100% equipment rated for continuous duty.
- .3 The voltage rating of the transfer switch shall be no less than the system voltage rating. The continuous current rating of the transfer switch shall be no less than the maximum continuous current requirements of the system.
- .4 The transfer switch shall be 100% equipment rated for continuous duty as shown on the drawings and shall conform to the applicable requirements of CSA 22.2 No. 178 for emergency system total load.
- .5 The automatic transfer switches shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed.

2.4 Construction

- .1 Power Switching Device – 400 Amp Bypass Isolation ATS Contactor Type
 - .1 Switches shall be Floor Standing construction.
 - .2 Switching devices for transfer switches shall be Contactor type mechanisms. All Contactors shall be CSA Certified for application in their intended enclosures for 100% of their continuous ampere rating.
 - .3 Switches shall operate with a time delay in the neutral position, adjustable from 0 to 120 seconds.
 - .4 Open transition, break before make.

- .5 The automatic transfer switch shall be three pole of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.
- .6 Contactors or components thereof not specifically designed, as an automatic transfer switch will not be acceptable.
- .2 The switching panel shall consist of a separate control or transformer panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.
- .3 Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically held in position in both normal and emergency positions.
- .4 Transfer switches will be supplied with a manual-operating handle. Manual operation shall only be performed with the switch de-energized.
- .5 On transfer switches requiring a fourth pole for switching, the neutral shall be identical to the other power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.
- .6 The transfer switch shall have a multi-tap voltage transformer for ease of voltage adjustment in the field.

2.5 Bypass Isolation Transfer Switch

- .1 The bypass isolation transfer switch shall be of draw-out configuration utilizing two identical and interchangeable contactors for the ATS and the Bypass switch individually seated in a wheeled truck assembly.
- .2 The ATS and the Bypass switch shall be contained in separate compartments located behind separate doors with padlockable handles.
- .3 An indicating light shall be provided to indicate a "Door Open" condition. The "Door Open" condition will inactivate any door mounted controls that are potentially unsafe to operate with the door open.
- .4 All control wiring shall be contained in a low-voltage compartment separated from the line voltage. All control wiring shall be harnessed with keyed disconnect plugs for ease of maintenance
- .5 The bypass isolation transfer switch shall be front accessible and the incoming source one, source two and load connections shall be in separate compartments accessible by removable panels.
- .6 Bus links shall be provided to allow for field configurable connections of top or bottom entry or a combination of both. Standard shall be with source one and load connections on top and source two connections on the bottom unless otherwise specified
- .7 The transfer to bypass shall be accomplished by operation of a single selector switch. The selector switch shall have two positions, "Auto" for operation on the ATS or "Bypass" for operation on the Bypass transfer switch. Control logic shall be designed so that the transfer to bypass will be to the connected source.
- .8 The microprocessor controller shall be actively controlling the bypass switch while in the bypass position. In the event of a power failure while on bypass, the transfer switch controller shall automatically transfer the bypass switch to the alternate source.

- .9 The bypass isolation transfer switch shall be electrically interlocked to prevent cross connection of sources when operated either automatically, or manually
- .10 Customer connections shall be wired out to a single terminal block mounted inside the enclosure.
- .11 The front panel of the bypass isolation transfer switch shall contain instructions on the operation of the bypass and isolation functions. Indicating lights shall be provided for Source Available and Source Connected for the operation in Auto or Bypass.
- .12 The ATS shall be capable of being racked-out with the enclosure door closed using a single motion. An indicating light shall be mounted on the door to indicate when the switch is isolated from the power and when the switch is in the racked-out position. A key interlock shall be provided to prevent the transfer switch from being racked out while the transfer switch is still powering the load.
- .13 The bypass isolation transfer switch shall have three positions: "Connected", "Isolated", and "Racked-Out". In the "Connected" position, the ATS is racked-in and is being actively monitored by the ATC controller indicated solid green light. In the "Isolated" position, the finger clusters on the ATS have been removed from the bus stabs and is indicated by a solid red light and in the "Racked-Out" position the ATS has been completely racked-out and disconnected from control power and is indicated by a flashing red light.
- .14 The Bypass Isolation transfer switch shall be interlocked to prevent the racking-in of either the ATS or the Bypass switch in a closed state.
- .15 The bypass isolation transfer switch shall have a 2-position Test/Manual selector switch. The "Test" position shall only be active while the ATS is in the Isolated or Racked-out position. This feature is used to test the electrical operation of the ATS. The "Manual" position shall be operable only when operating on the Bypass switch, while the ATS is in the Isolated or Racked-Out position and the automatic controller is deactivated. This feature is used to manually transfer the Bypass.
- .16 A detached handle shall be provided for manual operation of the switches in the Racked-Out position.
- .17 The ATS and the Bypass switch compartments are factory interconnected with silver plated copper bus.
- .18 Bypass Isolation transfer switch shall be painted ANSI 61 grey with white interior.

2.6 Microprocessor Logic

- .1 The automatic transfer switch controllers shall meet or exceed the following standards in addition to the basic switch standards:
 - .1 IEC 61000-4-2 - EMC Testing and Measurement Techniques - Electrostatic Discharge Immunity Test
 - .2 IEC 61000-4-3 - EMC Testing and Measurement Techniques - Radio-frequency, Electromagnetic Field Immunity Test
 - .3 IEC 61000-4-4 - EMC Testing and Measurement Techniques - Electrical Fast Transient/Burst Immunity Test
 - .4 IEC 61000-4-5 - EMC Testing and Measurement Techniques - Surge Immunity Test
 - .5 IEC 61000-4-6 - EMC Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radio-frequency Fields

- .6 IEC 61000-4-11 - EMC Testing and Measurement Techniques - Voltage Dips, Short Interrupts and Voltage Variations Immunity Tests
- .7 CISPR11, Class B - Industrial, Scientific and Medical Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
- .8 FCC Part 15, Subpart B, Class B
- .2 The transfer switch shall be controlled by a microprocessor-based controller. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.
- .3 The logic control panel shall control the operation of the transfer switch. All sensing and logic shall be controlled by an onboard microprocessor for maximum reliability and minimum maintenance. The logic controller shall be connected to the transfer switch by and interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnected from the transfer switch for routine maintenance.

2.7 Microprocessor-Based Controller

- .1 The microprocessor-based controller display shall be UV resistant and include a 2-line, 16 character, backlit LCD display. The controller shall be capable of displaying transfer switch status, parameters, and diagnostic data. All set point parameters shall be password protected and programmable using the controller keypad or remotely using serial port access.
- .2 The microprocessor-based controller shall include a mimic bus display consisting of four (4) individual LED's (3mm) for indicating the following:
 - .1 Availability status of source 1
 - .2 Availability status of source 2
 - .3 Connection status of source 1
 - .4 Connection status of source 2
- .3 The controller shall have a voltage range of 0-790 volts (50/60 Hz) and an accuracy of +/- 1% of nominal input voltage and a frequency range of 40-70 Hz and an accuracy of +/- .3 Hz.
- .4 Voltage and frequency dropout and pickup parameters are set as a percentage of the nominal voltage as indicated in the table below
- .5 The normal and emergency sources shall include phase reversal protection. The preferred rotation is programmable as ABC or CBA.
- .6 A time delay shall be provided on transfer to source 2, adjustable from 0 to 1800 seconds
- .7 A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds
- .8 A time delay shall be provided on retransfer from source 2 to source 1, adjustable from 0 to 1800 seconds
- .9 A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 1800 seconds
- .10 A time delay shall be provided for engine failure to start, fixed setting of 6 seconds

- .11 A pre-transfer time delay output adjustable from 0-120 seconds. The contact shall be a form-c contact rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc
- .12 All delays shall be field adjustable from the microprocessor-based controller without the use of special tools
- .13 Additional features:
 - .1 One Form A contact for closure of the generator start circuit. The contacts shall be of silver alloy with gold flashing. The contacts shall be rated for 5-Amp at 250-Vac and 5-Amp at 30-Vdc
 - .2 Programmable Engine Exerciser, selectable as disabled, 7, 14, or 28 day interval, adjustable 0-600 minutes, load or no load with Failsafe
 - .3 The controller shall include a keypad pushbutton to initiate a system test
 - .4 The controller shall include a keypad pushbutton to bypass the time delay on transfer to emergency and the time delay on retransfer to normal.
 - .5 The controller shall include a terminal input to accept a remote contact which closes to initiate a transfer to source 2. This feature shall be failsafe and an automatic retransfer shall occur in the event that source 2 power is lost.
 - .6 The controller shall include a terminal input to accept a remote contact which opens to inhibit transfer to source.
 - .7 One Form C auxiliary contact to indicate source 1 position and one Form C contact to indicate source 2 position. The contacts shall be rated for 10-Amp, 1/3-Horsepower at 250-Vac and 10-Amp at 30-Vdc.
 - .8 One Form C contact for source 1 present. The contacts shall be rated for 10-Amp, 1/3-Horsepower at 250-Vac and 10-Amp at 30-Vdc.
 - .9 One Form C contact for source 2 present. The contacts shall be rated for 10-Amp, 1/3-Horsepower at 250-Vac and 10-Amp at 30-Vdc.
 - .10 Historical Data Storage to include:
 - .1 Engine Run Time
 - .2 Source 1 Available Time
 - .3 Source 2 Available time
 - .4 Source 1 Connected time
 - .5 Source 2 Connected time
 - .6 Load Energized time
 - .7 Number of Transfers
 - .8 Date, Time and Reason for Last Sixteen (16) transfers
 - .9 Monitor Mode Event
 - .10 Fail Safe Event
 - .11 Aborted Test
- .14 Optional accessories:
 - .1 Non-Automatic Control: Provide a 2-Position Selector Switch, maintained contact, marked: "Automatic" and "Non-Automatic". The transfer switch shall be transferred by actuating a two position maintained selector switch labeled "Source 1" and "Source 2". A 30mm pilot light shall be provided labeled "Not in Automatic".
 - .2 Manual Retransfer Control: The ATS shall remain connected to the emergency source after the normal source becomes available until a momentary pushbutton contact closure signal is received to initiate the retransfer. Should a failure of the

emergency source occur while waiting for the manual return, the re-transfer proceeds automatically.

.3 Communications Interface to be Modbus 485 or Ethernet TCP/IP.

.4 Remote Annunciator and Controller:

.15 Monitoring Functions

.1 Display shall be a touchscreen color display capable of monitoring up to 8 transfer switches on one screen.

.2 General screen shall include a mimic bus display for each transfer switch with indication of source availability, based on controller pickup and dropout settings, and switch position.

.3 Each mimic bus display shall be marked with the designation of the transfer switch monitored.

.4 Display shall include indication of switch in test mode, manual retransfer status, and go to emergency status.

.5 Shall include the ability to view source data and event logs for each transfer switch.

.16 Control Functions

.1 Control functions shall be password protected and shall include:

.1 Initiate engine test.

.2 Initiate a failsafe transfer to source 2.

.3 Initiate manual retransfer.

.4 Alarm silence.

.2 Alarms

.1 Remote Annunciator shall provide audible and visual alarm when on source 2

.2 Visual alarm upon failure of communication link.

.3 Mounting: Flush, modular, unless otherwise indicated.

.4 Communications capability to be compatible with ATS controller.

2.8 Wiring/Terminations

.1 Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.9 Enclosure

.1 Each transfer switch shall be provided in a NEMA 1 enclosure c/w sprinkler hoods suitable for use in environments indicated in the drawings.

2.10 2.12 Finish

.1 NEMA 1 enclosures and hoods shall be painted with the manufacturer's standard light gray ANSI 61 paint.

2.11 Source Quality Control

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.

- .2 Tests:
 - .1 Operate equipment both mechanically and electrically to ensure proper performance.
 - .2 Check selector switch, in modes of operation Test, Auto and record results.
 - .3 Check voltage sensing and time delay relay settings.
 - .4 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.

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 transfer switches 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, install and connect transfer equipment as indicated.
- .2 Check solid state monitors and relays and adjust as required to ensure correct operation.
- .3 Install and connect remote alarms.

3.3 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

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.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 References

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 Canadian Standards Association (CSA International)
- .3 Underwriters' Laboratories of Canada (ULC)

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.
 - .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Divert unused metal materials from landfill to metal recycling facility.
- .5 Disposal and recycling of fluorescent lamps as per local regulations.
- .6 Disposal of old PCB filled ballasts.

PART 2 PRODUCTS

2.1 Drivers

- .1 LED Drivers
- .2 Reliable and consistent operation
- .3 High efficiency >90%
- .4 Greater than 0.9 PF and Less than 20% THD
- .5 Greater than 50,000 hrs life time
- .6 5-year limited warranty
- .7 ROHS compliance
- .8 Safety approbations (UL, CSA, CE, ENEC, PSE, SELV or CQC)
- .9 Dimmable and Programmable.
- .10 Designed to meet the needs of LED lighting
- .11 Available in either dedicated input voltage or Intellivolt options
- .12 The Adjustable Output Current (AOC) feature
- .13 Specific dimmable versions to enable use of lighting controls to help increase energy saving through a wide variety of protocols, such as 0-10V

2.2 Finishes

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

2.3 Optical Control Devices

- .1 As indicated in luminaire schedule.

2.4 Luminaires

- .1 As indicated in luminaire schedule.

PART 3 EXECUTION

3.1 Installation

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

3.2 Wiring

- .1 Connect luminaires to lighting circuits:
 - .1 Install flexible conduit or AC90 type wire for final connection to luminaires from conduit system with a maximum length of 1500mm. Using flexible conduit or AC90 as a "jumper" between luminaires is not permitted.

3.3 Luminaire Supports

- .1 For suspended ceiling installations support luminaires independently of ceiling.

3.4 Luminaire Alignment

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.5 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA International
 - .1 CSA C22.2 No.141-10, Emergency Lighting Equipment.

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 emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

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 emergency lighting for incorporation into manual.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect emergency lighting from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 Warranty

- .1 For batteries in this Section 26 52 00 - Emergency Lighting, 12 months warranty period is extended to 120 months including labour.

PART 2 PRODUCTS

2.1 Equipment

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 120 V, AC.

- .3 Output voltage: 12 V DC.
- .4 Operating time: 30 minutes.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit and remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED, minimum 5 W, minimum 340 lumen minimum output.
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: white.
- .13 Provide Auxiliary equipment:
 - .1 Test switch.
 - .2 Time delay relay.
 - .3 Battery disconnect device.
 - .4 AC input and DC output terminal blocks inside cabinet.
 - .5 Shelf.
 - .6 Cord and single twist-lock plug connection for AC.
 - .7 RFI suppressors.
 - .8 Voltage Sensing Relay (VSR)

2.2 Wiring Of Remote Heads

- .1 Conduit: type EMT, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: RW90 type in accordance with Section 26 05 21 - Wires and Cables (0-1000 V), sized as indicated.

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 emergency lighting 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 unit equipment and remote mounted fixtures.
- .2 Direct heads.
- .3 Connect exit lights to unit equipment.

3.3 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.

3.4 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by emergency lighting installation.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-02, Unit Equipment for Emergency Lighting.
 - .2 CSA C860-01(December 2002), Performance of Internally-Lighted Exit Signs.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 101-2006, Life Safety Code.

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

PART 2 PRODUCTS

2.1 Standard Units

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: Fully Gasketted Polymeric enclosure
- .3 Face plates: Heavy Duty Vandal resistant polycarbonate
- .4 Lamps: 2.5W LED
- .5 Green pictogram type.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.

3.3 Cleaning

- .1 Proceed in accordance with Section 01 74 11 - 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 American National Standards Institute
 - .1 ANSI J-STD-607-A-(2002), Joint Standard - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .2 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-606B-(2012), Administration Standard for Telecommunications Infrastructure.
 - .2 TIA-607-C (2015), Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- .3 U.S. Department of Labor/Occupational Safety and Health Administration (OSHA)
 - .1 Nationally Recognized Testing Laboratory (NRTL).

1.2 System Description

- .1 Telecommunications grounding and bonding system consist of grounding busbars, bonding backbones, and other bonding conductors.
- .2 Provides ground reference for telecommunications systems within building and bonding to it of telecommunications rooms.
- .3 Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are bonded to telecommunications grounding and bonding system.

1.3 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 Delivery, Storage And Handling

- .1 Waste Management and Disposal:
- .2 Separate waste materials for reuse, recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Secondary Bonding Busbar (Sbb)

- .1 Predrilled copper busbar, approved, listed by NRTL, electrotin plated with holes 8 mm diameter for use with standard-sized lugs to: ANSI J-STD-607-A.
- .2 Dimensions 6 mm thick, 50 mm wide, 300mm long to: ANSI J-STD-607-A.

2.2 Telecommunications Bonding Conductor (Tbc)

- .1 3/0 AWG copper conductor, green, insulated, Plenum rated marked to: ANSI J-STD-607-A.

2.3 Backbone Bonding Conductor (Bbc)

- .1 3/0 AWG copper conductor, green, insulated, Plenum rated marked to: ANSI J-STD-607-A.

2.4 Warning Labels

- .1 Non-metallic warning labels in English and French to: ANSI J-STD-607-A.
- .2 Identify labels with wording "If this connector is loose or must be removed, please call the building telecommunications manager".

PART 3 EXECUTION

3.1 Secondary Bonding Busbar (Sbb)

- .1 Install SBB in Server room.
- .2 Install 3/0 AWG copper BBC from SBB in room 483 to existing SBB in 4th floor Telecom room 4120.
- .3 Install #6 AWG copper bonding conductor from SBB to alternating current equipment ground (ACEG) of serving electrical power panel (Panelboard).
- .4 Use approved 2 hole compression lugs for connection to SBB.

3.2 Bonding Conductors General

- .1 When placed in ferrous metallic conduit or EMT longer than 1 m, bond to each end of conduit or EMT using grounding bushing with 6 AWG copper conductor.

3.3 Bonding Conductor For Telecommunications

- .1 Install bonding conductor for telecommunications from SBB to service equipment (power) ground.
- .2 Use approved 2 hole compression lugs for connection to SBB.

3.4 Telecommunications Bonding Backbone (Tbb)

- .1 Install TBBs from existing SBB in room 4120 to SBB in room 483 as indicated.
- .2 Use approved 2 hole compression lugs for connection to PBB and SBBs.

3.5 Backbone Bonding Conductor (Bbc)

- .1 Install BBC between SBBs in multi-storey building by bonding SBBs with BBC on top floor and every third floor in between top and bottom floors.

3.6 Bonding To Sbb

- .1 Bond metallic raceways in Server room 483 to SBB using #6 AWG green insulated copper conductor.
- .2 For cables within Server equipment room having shield or metallic member, bond shield or metallic member to SBB using #6 AWG green insulated copper conductor.
- .3 Bond equipment rack and cabinet located in Server equipment room to SBB using #6 AWG green insulated copper conductor.

3.7 Labelling

- .1 Apply warning labels to telecommunications bonding and grounding conductors.
- .2 Apply additional administrative labels to: TIA/EIA-606B.

END OF SECTION

PART 1 GENERAL

1.1 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 communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan and Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75 % of construction wastes were recycled or salvaged.

1.2 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance 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.
 - .2 Store and protect communication raceway systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, packaging materials, crates, padding, as specified in Waste Reduction Workplan and Construction Waste Management Plan in accordance with 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 System Description

- .1 Telecommunications raceways system consists of outlet boxes, cover plates, cabinets, conduits, cable trays, pull boxes, sleeves and caps, fish wires, service poles, service fittings.
- .2 Contractor to provide separate pathways for intrusion alarm, access control, sound masking, audio video, telecommunications and other systems.

2.2 Hangers And Supports For Communications Systems

- .1 Hangers and Supports
 - .1 Cable tray shall be supported by Cantilever brackets, Trapeze Brackets, or individual rod suspension, Supports shall be accepted types of wall brackets or trapeze hangers. Additional bracing may be required for seismic restraints.
 - .2 Conduits entering a room shall be appropriately racked on a trapeze support suspended from the structure.
 - .3 Cable tray shall be supported via Manufactures brackets, or supports manufactured on site using U-Channel, meeting all the manufacturers' requirements for loading.
 - .4 Conduits shall be independently supported, free from any other mechanical system.
 - .5 Conduit and cable tray support systems shall be securely and adequately installed to preclude movement of conduit and cable tray during pulling operations.
 - .6 J-hooks are not authorized for Telecommunications Distribution.

2.3 Conduit, Pull Boxes And Outlet Boxes For Communications Systems

- .1 Metallic Conduit
 - .1 EMT, reamed and bushed at both ends.
 - .2 Minimum Size for Telecommunications is 27mm outside diameter.
 - .3 Minimum Size for Access Control 21mm outside diameter.
 - .4 Minimum Size for Intrusion Alarm system 21mm outside diameter.
 - .5 Minimum Size for Sound Masking system 21mm outside diameter.
 - .6 Installed above ceilings under access floors and in walls only, not acceptable for in floor use.
- .2 PVC Conduit
 - .1 Is not acceptable.
- .3 Flexible Metal Conduit
 - .1 Not acceptable.
- .4 Pull Boxes
 - .1 Shall be made of code gauge steel and shall have a rust resistant finish.
 - .2 Shall be constructed in accordance with Canadian Standards Association.
 - .3 Shall be sized in accordance with charts as identified on the drawings.
- .5 Outlet Boxes for Telecommunications systems
 - .1 Double gang, minimum 100mm x 100mm x 65mm deep and flush mounted in all areas.
 - .2 Outlet boxes shall be installed in locations identified The outlet box shall be installed at 300mm AFF or at the same height and within 300mm of the adjacent electrical duplex receptacles, unless otherwise noted on the building plans. Wherever possible, the face of the plaster ring should be installed flush with the finished wall.

- .3 Back to back outlet boxes shall not be used.
- .4 Outlet boxes must be equipped with a plaster ring to accommodate the installation of telecommunication face plates.
- .5 Plaster rings will be specified as single gang.
- .6 Plaster rings or raised adapter plates shall not reduce the size of the outlet

2.4 Cable Tray For Communications Systems

- .1 Basket Style Cable Tray shall be a pre-fabricated structure, minimum 300 mm wide by 50mm tall, 400mm wide x 50mm tall, 600mm wide by 50mm tall and 300mm wide by 100mm tall consisting of a Basket bottom within basket two side rails.
- .2 Shall be supported as per manufacturer's instruction and applicable codes.
- .3 Proper manufactured fittings; accessories and fittings such as elbow, reducers, crossovers, tees, and risers will be used for any change of direction, height or size of the basket cable tray.
- .4 Acceptable Products: Cablofil Part # CF-54/300-304L, Cablofil Part # CF-54/400-304L, Cablofil Part # CF-54/600-304L and Cablofil Part # CF-100/300-304L. WBT Part # WBT2X12-S, WBT Part # WBT2X16-S, WBT Part # WBT2X24-S and WBT Part # WBT4X12-S. Flextray Part # Ft2x12x10-304S, Flextray Part # Ft2x16x10-304S, Flextray Part # Ft2x24x10-304S and Flextray Part # Ft4x12x10-304S.

2.5 Over-Floor Raceway

- .1 Smaller, narrower, lower raceway profile reduces potential trip hazards while also being installer friendly to speed installations.
- .2 Installs in open space areas. Provides power, communication, and A/V wiring to areas where in-floor or ceiling distribution are not accessible options.
- .3 Multiple channel base.
- .4 Four-channel raceway provides space for multiple combinations of power, communication and A/V to be provided through a single raceway installation.
- .5 Black powder coat finish.
- .6 Durable textured finish resists scuffing and scratches, is paintable and blends with most decors.
- .7 Raceway accepts Open System device plates that provide connectivity to a wide range of devices from leading communication and A/V providers.
- .8 Attaches directly to floor covering.
- .9 Works with carpet, tile, wood, etc. No need to remove or alter floor coverings. Ideal for both temporary and permanent installations.
- .10 Transition fittings are available to feed Overfloor Raceway from wall-mounted raceway systems.

- .11 Raceway cover is difficult to remove without the proper tools, discouraging unwanted access to raceway-provided services.
- .12 Meets Barrier Free Accessibility Guidelines. Low profile, unobtrusive design meets the Barrier Free Accessibility Guidelines that pertain to ADA Standard 4.5 which addresses changes in floor and ground surface levels. cETLus Listed.
- .13 Include all grounding, pre-manufactured fittings and transitions outlet boxes and faceplates for a complete system wiring.

2.6 Wall Box Behind Tv/Monitor

- .1 Designed to fit and be concealed behind 1.067m or larger flat screen displays.
- .2 Can be installed in both new work and old work applications.
- .3 Shall have 2 NEMA size openings for power, communication, or A/V devices.
- .4 Box shall be equipped with a storage module that will accept active A/V equipment up to 175mm x 232mm (dimensions include wire and cables) in size.

2.7 Flexible Plenum Duct

- .1 To be used for category 3 backbone cable installed in plenum space.
- .2 Shall be Super Flexible and shall not kink in normal usage.
- .3 Shall be complete with UL Listed pull line
- .4 Shall have sequential footmarks printed.
- .5 Shall meets and exceeds test method UL-910 for fire and smoke characteristics
- .6 Provides a clean, extremely low friction path for cable installation in building environments.
- .7 Characteristics:
 - .1 ASTM Specification: D2863, D149, D150
 - .2 Color: Orange
 - .3 Material: PVDF Resin
 - .4 Tape: Yes
 - .5 UL Listing: UL STD 2024 (Test 910), UL94
 - .6 Nominal Outside Diameter in: 1.350
 - .7 Nominal Outside Diameter mm: 34
 - .8 Inside Diameter in: 1.10
 - .9 Inside Diameter mm: 28

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 communication raceway systems 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 empty raceway system, including underfloor, overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable tray, service poles, miscellaneous and positioning material to constitute complete system.

3.3 General Installation Requirements

- .1 Install all systems as per the CEC and manufacturers recommended installation procedures.
- .2 Ground and bond all conduits and cable tray in accordance with section 27 05 26.
- .3 Refer to section 27 11 00 for Ladder rack in Telecom Rooms.
- .4 Provide separate conduit/cable tray system for all Telecommunications Systems.
- .5 Provide the following separation from Electrical Power systems installed in conduits:
 - .1 50mm from circuits of 300Volt and less.
 - .2 600mm from circuits 300Volt and higher.
 - .3 2 Metres from Circuits between 600V and 15KV.
 - .4 3 Metres for circuits above 15KV.
 - .5 300mm clear above cable trays.
 - .6 Electrical systems cannot share the same cable tray.
 - .7 150 mm below cable trays.
- .6 Heights of Communications system Outlet Boxes:
 - .1 Refer to Section 27 05 00 for heights of communications outlet boxes.

3.4 Installation Of Hangers And Supports For Communications Systems.

- .1 Support Cable tray with acceptable types of wall brackets, trapeze supports. Plumbers perforated straps are not permitted means of supports.
- .2 Centre hung or spine cable tray is not acceptable for telecommunications cabling.
- .3 Conduits and equipment shall be independently supported, free from any other mechanical system.
- .4 Conduit and Cable Tray support systems shall be securely and adequately installed to preclude movement of conduit and cable tray during pulling operations.

- .5 Telecommunications outlet boxes shall not be placed back to back with another telecommunications outlet box or any other box.
- .6 Maximum Height for installed telecommunications systems is 11ft.
- .7 Only Communications system can be attached to the trapeze supports of the cable tray.
- .8 Power or mechanical controls shall not be attached to Telecommunications Racking.

3.5 Installation Of Conduit, Pull Boxes And Outlet Boxes For Communications Systems.

- .1 Conduit Installation Requirements
 - .1 All Communications systems shall be installed in conduit or cable tray unless otherwise indicated.
 - .2 The inside radius of a bend in conduit shall be not less than 10 times the internal diameter of the conduit.
 - .3 All Conduits shall be identified and labelled at both ends. Tags shall identify start and finish of conduit.
 - .4 A Maximum of one Telecommunications outlet per 27mm conduit run.
 - .5 Back to back or offset outlets shall not be used.
 - .6 All Conduits shall originate in the Telecommunications room, pull box or cable tray.
 - .7 Conduits shall be rigidly and adequately fastened to withstand pulling tensions as per manufacturer's recommendations.
 - .8 Conduits must follow building lines.
 - .9 90-degree LB,LL,LR, or condulets shall not be used in any instance for telecommunications cabling.
 - .10 A pull box shall be installed in conduit runs where:
 - .1 The length of conduit is over 30 metres
 - .2 There are more than two 90-degree bends
 - .11 Offsets or kicks are to be considered 90 degree bend for telecommunications
 - .12 Conduits protruding through the floor shall be terminated 25-50 mm(1-2") above the finished floor.
 - .13 Riser sleeves protruding through the floor shall be terminated 25-75mm(1-2") above the finished floor, including sleeve and bonding bushing.
 - .14 Conduits entering and exiting through the ceiling of a Telecommunications Room (TR) shall protrude into the room 25-50mm (1-2") above the 2400mm (8ft) level.
 - .15 All zone conduits entering a TR (unless otherwise stipulated will protrude into the TR from 25-50 mm (1-2") without a bend.
 - .16 The maximum fill rate authorized for conduits is 40 percent.
 - .17 Pull boxes shall not be installed higher than 11 ft above finished floor. Acceptance of this deviation is on a case by case basis.
 - .18 Telecommunications conduits shall NEVER be run over:
 - .1 Boilers
 - .2 Incinerators
 - .3 Hot Water lines
 - .4 Steam lines

- .5 Electrical rooms and Closets
- .6 Washrooms
- .19 All Conduits shall be bonded in accordance with section 27 05 26 and the CEC.
- .20 All Conduits shall use the trapeze hanger method to support the conduits, shall use threaded rod not less than 3/8" diameter.
- .21 Install pull string in all conduits and cable tray tied at both ends for installation by Voice data system contractor.
- .2 Pull Box Installation requirements
 - .1 In all instances pull boxes shall be placed in straight sections of a conduit run and shall NOT be used in lieu of a bend. Corresponding ends of the conduit are to be aligned with each other. Conduit fittings shall not be used in place of pull boxes. Conduits shall always protrude in the direction of pull. Conduits shall not exit the sides bottom or back of the pull box.
 - .2 All Communications system conduits including Public Address and Electronic Security and Safety Systems shall follow the requirements of this section.
 - .3 Pull boxes shall be placed in an exposed location, and readily accessible. Pull boxes shall not be placed in a fixed false ceiling space, unless immediately above a suitably marked and hinged panel. If the pull box is installed above a suspended type ceiling a green indicator dot shall be placed on ceiling t-rail to indicate the location of pull box.
 - .4 All Boxes shall be adequately secured. They shall not be supported by the conduits entering the box.
 - .5 Riser cables and Telecommunications outlet cannot share the same conduit system or pull boxes.
- .3 Outlet Box installation requirements
 - .1 Install Telecommunications Outlet boxes for voice data systems same level as adjacent receptacles and flush to the wall wherever possible.
 - .2 Where Telecommunications Outlets are installed in steel stud type systems, provide additional cross bracing and or straps to make the installation completely rigid prior to the application of the wall facing material.
 - .3 Back to back and offset outlets shall not be used.
 - .4 Apply appropriate acoustic sealing as necessary on back of telecommunications outlet boxes to ensure the STC rating is maintained.
 - .5 Ensure conduits are installed not to de-rate the STC rating of the wall.
 - .6 Ensure Outlet Box is mechanically bonded to the Conduit system.
 - .7 Conduits must enter the outlet box from the top or bottom.

3.6 Cable Tray For Communications Systems

- .1 Cable tray shall be installed above false ceilings or below access floors. Under no circumstances shall cable tray be installed above a fixed ceiling. Provide a minimum of three 103mm conduits to transition the fixed ceiling portions. Install additional conduits if the fill rating of the cable require additional conduits.
- .2 Cable Trays installed 150mm above a false ceiling with 300mm clear access above. Cable tray shall be installed with separation from sources of EMI and electrical power system as indicated.

- .3 Please refer to the Canadian Electrical Code Part 1, 12-2000(6) for minimum cable tray clearances
- .4 Communications Cable Tray shall NEVER be run over:
 - .1 Boilers
 - .2 Incinerators
 - .3 Hot Water lines
 - .4 Steam lines
 - .5 Electrical rooms and Closets
 - .6 Washrooms
- .5 Support Cable Tray to suit loading and recommended support requirements in the Canadian Electrical Code, Part 1, for the applicable class. A Support shall be placed within a maximum of 610mm on either side of any connection to a fitting and 1524mm on centre as recommended by the cable tray manufacturer. Cable Tray shall be adequately fastened to withstand pulling tensions as per manufacturers recommendations.
- .6 Remove any burrs, sharp edges, or projections that may damage cables.
- .7 Install proper manufactured accessories and fittings such as elbows, reducers, crossovers, tees and risers for any change of direction, height or change of direction of the cable tray. Vented accessories shall be used.
- .8 Install cable tray a minimum of 300mm from fluorescent luminaries, Power cables shall cross at right angles to communications cables with the separation distances as indicated.
- .9 Install Cable tray either using angle brackets or trapeze, ensure only communications systems can be racked to the bottom of the tray. Electrical power or Mechanical controls shall not be racked or installed using communications equipment supports or hangers.
- .10 Install Grounding and Bonding in accordance with section 27 05 26.
- .11 Ensure other building components, i.e.: mechanical ducts, sprinkler pipes, luminaries, etc do not restrict access to Communications cable tray.
- .12 Mark Cable Tray at each transition or connection.

3.7 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 Waste Management: separate waste materials for recycling, reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.8 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by pathways for communications systems installation.

END OF SECTION

PART 1 GENERAL

1.1 System Description

- .1 Communications Labeling consists of the unique identifiers attached to all telecommunications systems.

1.2 Submittals

- .1 Refer to Section 27 05 00 for references Submittal procedures to this project.

1.3 Definitions

- .1 Backbone Pathway: The portion of the pathway system that permits the placing of main and high-volume cables between the entrance location and all cross-connect points within the building and between buildings.
- .2 EMT: Electrical Metallic Tubing, Thin wall metal tubing that does not have threaded ends, which is widely used in electrical distribution systems and as a pathway for telecommunications cabling.
- .3 Space: An Area used for housing the installation and termination of telecommunications equipment and cable.
- .4 Utility Column: An enclosed pathway extending from the ceiling to furniture or to the floor that forms a pathway for telecommunications cable.
- .5 Telecommunications Outlet Box. A housing used to hold telecommunications outlet/connectors.

PART 2 PRODUCTS

2.1 Pathway Systems Labels

- .1 CABLE TRAY LABELS
 - .1 Shall be Machine printed labels 50mm high x 75mm long
 - .2 White Colour, Adhesive backed, Polyester type
- .2 CONDUIT LABELS
 - .1 Shall be Machine printed labels 25mm high x 50mm long
 - .2 White Colour, Adhesive backed, Polyester type
- .3 GROUND SAFETY LABELS
 - .1 Shall be pre-manufactured labels 50mm high x 75mm long
 - .2 Yellow Colour, Green writing, non Adhesive backed, Rigid Plastic Tag
 - .3 Printed with the following text in BOLD " IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CONTACT THE BUILDING TELECOMMUNICATIONS MANAGER"

- .4 GROUNDING BUSBAR LABELS
 - .1 Shall be Machine printed labels 50mm high x 75mm long
 - .2 White Colour, Adhesive backed, Polyester type
- .5 GROUNDING CABLE RISER LABELS
 - .1 Shall be Machine printable labels 12.7mm high x 50mm long
 - .2 white Colour, non Adhesive backed, polyester polycarbonate data plate
- .6 COPPER RISER LABELS
 - .1 Shall be Machine printable labels 12.7mm high x 50mm long
 - .2 white Colour, non Adhesive backed, polyester polycarbonate data plate
- .7 OPTICAL FIBRE RISER LABELS
 - .1 Shall be Machine printable labels 12.7mm high x 50mm long
 - .2 white Colour, non Adhesive backed, polyester polycarbonate data plate
- .8 HORIZONTAL CABLE LABELS
 - .1 Shall be Machine printed labels 19mm high x 12.7mm long 6.35mm print area
 - .2 White Colour, Adhesive backed, Polyester type wraparound text.
- .9 OUTLET IDENTIFICATION LABELS
 - .1 Shall be Machine printed labels 73mm high x 75mm long.
 - .2 White Colour, Adhesive backed, Polyolefin type Laser Printed.
- .10 RACK IDENTIFICATION LABELS
 - .1 Lamacoid 50mm high x 100mm long
 - .2 BLACK in Colour, with white Text 25mm high.
- .11 SYSTEM IDENTIFICATION LABELS
 - .1 Primary system colour label 50mm Vinyl Tape
 - .2 Secondary system colour label 12.7mm Vinyl Tape

PART 3 EXECUTION

3.1 General Installation Requirements

- .1 Install all labels to ensure Machine printing does not rub off under normal wear
- .2 Label conduit/cable tray system for the following systems:
 - .1 Telecommunications System.
- .3 Primary/Secondary Colour for Communications Systems:
 - .1 Telecommunications System conduits and cable tray: Green
- .4 Label all conduits at point where visibly where conduit enters wall, at all pull boxes and couplings for each system in the colours indicated.

- .5 Label all Cable tray at 50mm from each connection and transition in the colours indicated for each system
- .6 Wall Mount IDC Colour for Communications Risers and Voice services:
 - .1 Demarcation Point from Service Provider: Orange
 - .2 Owner network connection from Service Provider: Green
 - .3 Termination point from PBX, LAN or MUX: White
 - .4 First Level Backbone: Purple
 - .5 Second Level Backbone: Grey
 - .6 Horizontal Cable: Blue
 - .7 Interbuilding: Brown
 - .8 Auxiliary Circuits, alarms, maintenance, security and misc: Yellow
 - .9 Key Telephone systems: Red

3.2 Conduit Labeling

- .1 Label conduits where they penetrate the wall to the telecom outlet. The label shall indicate the pull box or cable tray and the outlet IE: TRXXX 2E01 – PBTRXXX-01 or TRXXX 2E01 – CTTRXXX-XX.

3.3 Pull Box Labeling

- .1 Label All Pull Boxes on the visible exterior with the PB number IE: PBTRXXX-XX.

3.4 Cable Tray Labeling

- .1 Label Cable Trays at each connection and transition with the cable tray label IE: CT-TR-XXX-XX

3.5 Sbb/Pbb Labeling

- .1 Label PBB/SBB IE: SBB TR-XXX.

3.6 Bonding Conductors For Telecommunications

- .1 Label Bonding conductors at each connection to Equipment, Cable tray and the PBB/SBB. IE: SBB-MTR-XXX – SBB-TR-XXX.

3.7 Copper Backbone Labeling

- .1 Label Copper Backbone Cables at point where cable enters the Telecom Room or Main Telecom Room. IE: CR MTR-XXX 1-XXX – CR TR-XXX 1A-XX – 1XXX.

3.8 Multi Mode Fibre Backbone Labeling

- .1 Label Multi Mode Backbone Cables at point where cable enters the Telecom Room or Telecommunications Entrance Facility. IE: MTR - TEF-XXX 1-XXX – FOM - TR-XXX 1A-XX – 1XXX.

3.9 Single Mode Fibre Backbone Labeling

- .1 Label Single Mode Backbone Cables at point where cable enters the Telecom Room or Main Telecom Room. IE: FOS - MTR-XXX 1-XXX – FOS - TR-XXX 1A-XX – 1XXX.

3.10 Rack Labeling

- .1 Label Racks in Each Telecom Room or Main Telecom Room. IE: TR-XXX R1, R2, R3.

3.11 Patch Panel Labeling

- .1 Label patch panels Each Telecom Room or Main Telecom Room. IE: A, B, C, D etc.

3.12 Patch Panel Port Labeling

- .1 Label all ports in patch panel for each Telecom Room or Main Telecom Room. 1-X.

3.13 Horizontal Cabling Labeling

- .1 Label all horizontal cables 25mm from each end with the patch panel and telecom room designation each Telecom Room or Main Telecom Room. IE: TR-XXX 2E01.

3.14 Telecom Outlet Faceplate Labeling

- .1 Label all faceplates with TR Designator and label each port with Rack/Patch panel Designator patch panel. IE: TR-XXX, Ports 2E01, 2E02, 2E03, 2E04.

3.15 Ground Safety Labeling

- .1 Label all Bonding conductor connections to either the TGB or TMGB with Bonding conductor safety label.

END OF SECTION

PART 1 GENERAL

1.1 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 communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit Construction/Demolition Waste Management and Disposal in accordance with Section 01 74 21.

1.2 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect communication raceway systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 TEST DEFINITIONS

2.1 General

- .1 Unless otherwise specified herein, all testing definitions, parameters, methods, and practices shall comply with the current codes and standards.

PART 3 EXECUTION

3.1 Communications Grounding Systems Testing

- .1 The purpose of this test is to ensure proper grounding and bonding of the telecommunications system.
- .2 Tests To Be Performed
 - .1 The following tests shall be performed. Multiple steps are necessary for each test.
 - .1 Grounding Reference System Continuity Test.

Note: The continuity of each equipment bonding conductor (EK) is NOT part of this procedure.
 - .3 The ground reference system to be testing is shown on the Ground Reference System Schematic on the Drawings for each building. See the building Drawings.
 - .4 Test Equipment
 - .1 Test Equipment: Biddle Instruments, megger DET2/2 Ground Tester or later acceptable model.
 - .5 Testing Guidelines
 - .1 The following testing guidelines apply to all test procedures and shall be followed to promote efficient and accurate testing.
 - .2 Be sure all connections are tight. Loose connections will drastically affect the test results.
 - .3 The test lead shall be No. 14 AWG, stranded, insulated, copper conductor. The test lead shall be long enough to reach all SBBs from the PBB. One test lead shall be used for all tests.

Note: The test lead may be spooled however, the Biddle meter may produce inaccurate or erratic resistance measurements if the quantity of cable on the spool is too great. If the meter behaves erratically first try performing the test in the "low current" setting. If the behavior persists, the test lead should be un-spooled.
 - .4 The Current shall be set to "HIGH".
 - .5 The Filter shall be set to "ON".
 - .6 The Frequency shall be set to "150 Hz".
 - .7 Connect terminals C2 and P2 by a jumper wire (if not connected by the manufacturer).
 - .8 Connect Terminals P1 and C1 by a jumper wire (if not connected by the manufacturer).
 - .9 Once the test lead is attached to the meter it should not be removed as identified in the specific test procedure.
- .6 Reference Test
 - .1 The reference test procedure is necessary to calibrate the test setup. The reference test procedure shall be performed prior to performing any test.

- .2 The reference value shall be recorded and subtracted from all other measurements. If the length of the test lead is changed, new reference data must be taken and recorded. Refer to the test documentation
- .7 Reference Test Procedure
 - .1 The test procedure follows:
 - .2 Connect one end of the test lead to Terminal C1 and the other end to Terminal C2.
 - .3 Perform the Biddle Meter Resistance Test.
 - .4 Record test lead resistance on the data sheet.
 - .5 Disconnect the test lead from Terminal C1 ONLY. The test lead should remain connected to Terminal C2 if possible throughout the tests.
- .8 Ground Reference System Continuity Test
 - .1 The ground reference system shall be tested to validate the continuity and integrity of the interconnection of the PBB, SBB, TBB, IC, and building's grounding electrode.
- .9 Ground Reference System Continuity Test Procedure
 - .1 The test procedure follows. Refer to Figure 3.2.1.
 - .2 Remove all equipment bonding conductors (EKxxx) from the PBB and the SBBs. The IC shall remain attached to the PBB. Panelboard and building steel bonds shall be removed. The TBB conductor (interconnecting the PBB and SBBs) shall remain attached at all busbars.
 - .3 Move the meter and test lead to the first SBB to be tested. Route the test lead to the PBB and connect the test lead to the PBB. The other end of the test lead should still be connected to Terminal C2 from the Reference Test. Connect a short test lead (typically from the manufacturer) from Terminal C1 to the SBB to be tested.
 - .4 Perform the Biddle Meter Resistance Test.
 - .5 Record the resistance on the data sheet.
 - .6 Attach the equipment bonding conductor from the panelboard (if the panelboard is located within the room) to the SBB and repeat the test. Record the resistance on the data sheet. The reading may be slightly less than the first reading.
 - .7 Attach the equipment bonding conductor from the building steel (if applicable) and repeat the test. Record the resistance on the data sheet. The reading may be slightly less than the previous reading.
 - .8 This completes the grounding system continuity test for this SBB. Leave the building steel and panelboard ground connected to this SBB. Repeat the test for all other SBBs.
 - .9 The test results should be in the order of a few 10ths of an ohm (approximately 0.10 to 0.90). The measured value should decrease when the panelboard and building steel grounds are added.

PART 4 TEST RESULTS DATA SHEET

Project Name: _____

Crew Members: _____

Test Date: _____

Tester used: _____

Current (High \ Low) _____

Serial Number: _____

Filter (on \ Off) _____

Frequency (Hz) _____

SBB Identification: _____

Reference Test Resistance: _____ W

Table 4.0 Test Results

Ground Reference System Continuity Test Data					
TGSBB		SBB with Panelboard Ground		SBB with Panelboard and Building Steel Ground	
Reference	Test (Difference)	Reference	Test (Difference)	Reference	Test (Difference)
Ω	Ω	Ω	Ω	Ω	Ω

END OF SECTION

PART 1 GENERAL

1.1 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 communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit Construction/Demolition Waste Management and Disposal in accordance with Section 01 74 21.

1.2 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect communication raceway systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 TEST DEFINITIONS

2.1 General

- .1 Unless otherwise specified herein, all testing definitions, parameters, methods, and practices shall comply with the references listed in section 1.3.

- .2 Unless otherwise indicated, a permanent link test shall be performed on all horizontal cabling installed under the project and on existing cabling that are re-terminated, rerouted, and where the termination is disturbed to perform work under the project.
- .3 A permanent link test shall be performed on all horizontal cabling regardless of those outlets receiving data or voice circuits.
- .4 One week prior to scheduled cutover date the Departmental Representative shall receive from the contractor printed and electronic copper cable test results. Cutover shall not commence unless test results are submitted.

2.2 Utp Horizontal Link Definition For The Project

- .1 A link consists of up to 90 meters of horizontal cabling, a connection at each end, up to 2 meters of test equipment lead from the main unit of the hand-held tester to the local connection, and up to 2 meters of test equipment lead from the remote unit to the remote connection. A total length of up to 94 meters.
- .2 The connection to the equipment at each end of the link is not included in the link definition.

2.3 Optical Link Definition For The Project

- .1 Backbone (multimode and single mode) link
 - .1 The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA/EIA-568.1-D.
 - .1 $\text{Link Attenuation (dB)} = \text{Cable_Attn (dB)} + \text{Connector_Attn (dB)} + \text{Splice_Attn (dB)}$
 - .2 $\text{Cable_Attn (dB)} = \text{Attenuation_Coefficient (dB/km)} * \text{Length (Km)}$
 - .3 $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector_loss (dB)}$
 - .4 Maximum allowable connector_loss = 0.75dB.
 - .5 Splice attenuation = number_of_splices * splice_loss (dB)
 - .6 Maximum allowable splice_loss = 0.3 dB
 - .7 The values for the Attenuation_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

- .2 OTDR Testing
 - .1 Reflective events (connections) shall not exceed 0.75 dB.
 - .2 Non-reflective events (splices) shall not exceed 0.3 dB.

2.4 Documentation Requirements

- .1 The test documentation requirements are the minimum requirements. Obtain DEPARTMENTAL Representative's acceptance of the test documentation format and content prior to full-scale testing. Coordinate with DEPARTMENTAL Representative to get representative sample of the documentation format and content for review. Customize the information for the particular installation.
- .2 The following header fields on each test report shall contain the appropriate information. These are minimum requirements.
 - .1 Circuit ID
 - .2 Test Result
 - .3 Contractor Name
 - .4 Serial Number
 - .5 Injector Serial Number
 - .6 Software Version
 - .7 Date
 - .8 Cable Type
 - .9 Building
 - .10 Telecom Room
- .3 The information in each user definable header field on each test report shall contain the information as follows.
 - .1 Circuit ID: Indicate the Pair and patch panel under test
 - .2 User: Indicate the person performing the testing
 - .3 Date: Indicate the date of the test
 - .4 Cable Type: Indicate the cable type being tested
 - .5 NVP: Indicate the field measured NVP
 - .6 Building: Indicate the building where the cable is being tested
 - .7 Telecom Room: Indicate the Telecom Room identifier where the cable is terminated
- .4 The Contractor shall provide the test data in a complete and consistent format. All results shall be printed from a laser printer. Provide the printed results contained in 3" three-ring notebook binders. The test results shall be three-hole punched and numerically ordered by outlet location number within the notebook. Provide separate notebooks for each telecom room and Link Test results. Multiple volumes may be necessary. Separate all FAIL test results in each notebook from the PASS test results. Provide summary sheet of all results. Provide a separator tab labeled "Fail Results" in front of the sheets of FAIL test results. Provide a separator tab labeled "Pass Results" in front of the sheets of PASS test results.
- .5 The cover of the notebook shall read (italicized information is variable):

"PROJECT NAME"

building name "(BLDG. No. x)"

"Security Backbone Cable UTP Test Results"

"Volume No." X
date (month and year)

- .6 The contractor shall verify that a report for each jack in the Project is contained in the notebooks.
- .7 Electronic Copy
 - .1 The electronic copy of the test results shall be on CD.
 - .2 Disks shall be labeled. The label shall read:

"PROJECT NAME"

building name (BLDG. No. x)

"Security Backbone Cable UTP Test Results on Disk"

"Disk No." X of x

date (month and year)
 - .3 The files on disk shall be in Comma Separated Variable (CSV) file format PDF with a summary sheet and the native tester data file format.

PART 3 EXECUTION

3.1 Voice Grade Inside Plant Backbone Cabling Category 3 Riser Testing

- .1 The following tests shall be performed Category 3 Riser cabling:
 - .1 Wire Map
 - .2 Length
 - .3 Insertion Loss
 - .4 Continuity
- .2 Test Equipment
 - .1 Level IV certified up to and including Category 6 Testing
 - .2 Latest software revision
- .3 Test procedure
 - .1 Testing will be performed with the tester at the Common Equipment Room Facility and the injector at the location where the other end of the cable is terminated.
 - .2 Test leads have limited life cycles, Inspect and replace the test leads as necessary.
 - .3 Use only test leads specified by the tester manufacturer.
 - .4 Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization and calibration.
 - .5 Test every installed pair and document test results in electronic format.
- .4 Provide the Departmental Representative with both a printed and electronic files on CD of the test results.

3.2 Category 6 Testing

- .1 The following tests shall be performed the permanent link for category 6 cabling:
 - .1 Wire Map
 - .2 Length
 - .3 Insertion Loss
 - .4 NEXT Loss
 - .5 PS NEXT Loss
 - .6 ACR-F Loss
 - .7 PS ACR-F Loss
 - .8 Return Loss
 - .9 Propagation Delay
 - .10 Delay Skew
- .2 Test Equipment
 - .1 Level IV certified up to and including Category 6 Testing
 - .2 Latest software revision
- .3 Test Equipment setup procedures
 - .1 Autotest: Use the "Cat6e Link Full" Autotest from the Autotest List to perform the required link. Customize the Autotest as necessary to satisfy testing requirements and parameters.
 - .2 Cable type: Select the cable type being tested. Cable Type may vary. Always change the NVP as identified herein for the type of cable being tested.
 - .3 NVP: The Nominal Velocity of Propagation (NVP) shall be determined by field measuring a 150-foot piece of cable according to the manufacturers instructions. The cable shall be unspooled and physically measured with a tape measure. Do not use footage markings on the cable to determine 150 feet. The cable shall be terminated on both ends with an 8-pin modular jack. The Fluke DSP 43000 calculates the NVP based on the cable's shortest wire pair. The NVP shall be printed on the test report.
 - .4 Frequency Range: The frequency range for category 6 tests shall be 1 MHz to 2.4 GHz. The category 6 permanent link Autotest default frequency range is 1 MHz - 2 GHz.
 - .5 Cable pairs: Test all cable pairs. Select all pairs for TEST and all pairs for Pass/Fail criteria for Autotest.
 - .6 Length Units: Cable length test results shall be in metres
 - .7 Data Style: The date style shall be Medium date IE: 01 Jan 05
 - .8 Language: English
- .4 Test procedure
 - .1 Testing will be performed with the tester at the rack and the injector at the work area.
 - .2 Test leads have limited life cycles, Inspect and replace the test leads as necessary.
 - .3 Use only test leads specified by the tester manufacturer.

- .4 Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization and calibration.

3.3 Optical Fibre Testing

- .1 Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end-faces shall also be verified.
- .2 All Test Equipment manufacturers test adapters and cables shall be used for each type of cable tested.
- .3 Testing shall be performed on each cabling link, (connector to connector Length, propagation delay and loss)
- .4 Testing shall be performed on each cabling channel (equipment to equipment)
 - .1 Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
 - .2 All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode and single mode links and channels and OTDR traces and event tables for multimode and single mode links.
 - .3 Documentation shall also include optical length measurements.
 - .4 Identification shall be in accordance with section 27 05 53
- .5 Test Equipment
 - .1 Level III certified 10 GBit with Optical adapters or acceptable equivalent
 - .2 10 Gbit OTDR or acceptable equivalent.
 - .3 Latest software revisions
- .6 Optical Loss Testing
 - .1 Backbone Link
 - .1 Multimode backbone links shall be tested at 850nm and 1300nm in accordance with TIA-526-14A, Method B, One reference jumper or the equivalent method.
 - .2 Single Mode Backbone links shall be tested at 1310 nm and 1550 nm in accordance with TIA-526-7, Method A.1, One reference jumper or equivalent method.
 - .3 Backbone links shall be tested both ways
 - .4 Link attenuation does not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
 - .5 Use the One Reference Jumper Method specified by TIA-526-14A, Method B and TIA-526-7, Method A.1 or the equivalent method. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

- .7 OTDR Testing
 - .1 Backbone, horizontal and centralized links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 - .1 Backbone multimode: 850 nm and 1300 nm
 - .2 Backbone single mode: 1310 nm and 1550 nm
 - .3 Horizontal multimode: 850 nm and 1300 nm
 - .4 Centralized multimode: 850 nm and 1300 nm
 - .2 Each fiber link and channel shall be tested in both directions.
 - .3 A launch cable shall be installed between the OTDR and the first link connection.
 - .4 A receive cable shall be installed after the last link connection.
- .8 Length Measurement
 - .1 The Length of each fibre shall be recorded
 - .2 The optical length shall be measured using a OLTS or OTDR.
- .9 Polarity Testing
 - .1 Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with subclause 10.3 of ANSI/TIA/EIA-568.1-D. The polarity of the paired duplex fibers shall be verified using an OLTS.
- .10 Documentation
 - .1 The test Documentation requirements are the minimum requirements. Obtain DEPARTMENTAL Representative's acceptance of the test documentation format and content prior to full-scale testing. Coordinate with DEPARTMENTAL Representative to get representative sample of the documentation format and content for review.
 - .2 Provide the DEPARTMENTAL Representative with both a printed and electronic files on CD of the test results.
 - .3 The test report shall include the information shown in the Appendix-A sample, unless otherwise accepted by the DEPARTMENTAL Representative. The italicized information on the report is example information and is variable. Customize the information for the particular installation.
 - .4 The following header fields on each test report shall contain the appropriate information. These are minimum requirements.
 - .1 Identification of Site
 - .2 The name of the test limit selected to execute the stored test results
 - .3 The Name of the person performing the test.
 - .4 The Date and time the test results were saved in the memory of the tester.
 - .5 The manufacturer, model and serial number of the field-test instrument.
 - .6 The Fibre Identification number
 - .7 The Length for each optical fibre.
 - .1 The index of refraction used for length calculation when using a length capable OLTS

- .8 Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
- .9 Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
- .10 The Length for each optical fibre as calculated by the OTDR.
- .11 The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements.

3.4 Security System Ground Testing

- .1 The purpose of this test is to ensure proper grounding and bonding of the telecommunications system.
- .2 TESTS TO BE PERFORMED
 - .1 The following tests shall be performed. Multiple steps are necessary for each test.
 - .1 Grounding Reference System Continuity Test.
Note: The continuity of each equipment bonding conductor (EK) is NOT part of this procedure.
 - .3 The ground reference system to be testing is shown on the Ground Reference System Schematic on the Drawings for each building. See the building Drawings.
- .4 TEST EQUIPMENT
 - .1 Test Equipment: Biddle Instruments, megger DET2/2 Ground Tester or later acceptable model.
- .5 TESTING GUIDELINES
 - .1 The following testing guidelines apply to all test procedures and shall be followed to promote efficient and accurate testing.
 - .2 Be sure all connections are tight. Loose connections will drastically affect the test results.
 - .3 The test lead shall be No. 14 AWG, stranded, insulated, copper conductor. The test lead shall be long enough to reach all SBBs from the PBB. One test lead shall be used for all tests.
Note: The test lead may be spooled however, the Biddle meter may produce inaccurate or erratic resistance measurements if the quantity of cable on the spool is too great. If the meter behaves erratically first try performing the test in the "low current" setting. If the behavior persists, the test lead should be un-spooled.
 - .4 The Current shall be set to "HIGH".
 - .5 The Filter shall be set to "ON".
 - .6 The Frequency shall be set to "150 Hz".
 - .7 Connect terminals C2 and P2 by a jumper wire (if not connected by the manufacturer).
 - .8 Connect Terminals P1 and C1 by a jumper wire (if not connected by the manufacturer).

- .9 Once the test lead is attached to the meter it should not be removed as identified in the specific test procedure.
- .6 REFERENCE TEST
 - .1 The reference test procedure is necessary to calibrate the test setup. The reference test procedure shall be performed prior to performing any test.
 - .2 The reference value shall be recorded and subtracted from all other measurements. If the length of the test lead is changed, new reference data must be taken and recorded. Refer to the test documentation
- .7 REFERENCE TEST PROCEDURE
 - .1 The test procedure follows:
 - .2 Connect one end of the test lead to Terminal C1 and the other end to Terminal C2.
 - .3 Perform the Biddle Meter Resistance Test.
 - .4 Record test lead resistance on the data sheet.
 - .5 Disconnect the test lead from Terminal C1 ONLY. The test lead should remain connected to Terminal C2 if possible throughout the tests.
- .8 GROUND REFERENCE SYSTEM CONTINUITY TEST
 - .1 The ground reference system shall be tested to validate the continuity and integrity of the interconnection of the PBB, SBB, TBB, IC, and building's grounding electrode.
- .9 GROUND REFERENCE SYSTEM CONTINUITY TEST PROCEDURE
 - .1 The test procedure follows. Refer to Figure 3.2.1.
 - .2 Remove all equipment bonding conductors (EKxxx) from the PBB and the SBBs. The IC shall remain attached to the PBB. Panelboard and building steel bonds shall be removed. The TBB conductor (interconnecting the PBB and SBBs) shall remain attached at all busbars.
 - .3 Move the meter and test lead to the first SBB to be tested. Route the test lead to the PBB and connect the test lead to the PBB. The other end of the test lead should still be connected to Terminal C2 from the Reference Test. Connect a short test lead (typically from the manufacturer) from Terminal C1 to the SBB to be tested.
 - .4 Perform the Biddle Meter Resistance Test.
 - .5 Record the resistance on the data sheet.
 - .6 Attach the equipment bonding conductor from the panelboard (if the panelboard is located within the room) to the SBB and repeat the test. Record the resistance on the data sheet. The reading may be slightly less than the first reading.
 - .7 Attach the equipment bonding conductor from the building steel (if applicable) and repeat the test. Record the resistance on the data sheet. The reading may be slightly less than the previous reading.
 - .8 This completes the grounding system continuity test for this SBB. Leave the building steel and panelboard ground connected to this SBB. Repeat the test for all other SBBs.
 - .9 The test results should be in the order of a few 10ths of an ohm (approximately 0.10 to 0.90). The measured value should decrease when the panelboard and building steel grounds are added.

PART 4 TEST RESULTS DATA SHEET

Project Name: _____

Crew Members: _____

Test Date: _____

Tester used: _____

Current (High \ Low) _____

Serial Number: _____

Filter (on \ Off) _____

Frequency (Hz) _____

SBB Identification: _____

Reference Test Resistance: _____ W

Table 4.0 Test Results

Ground Reference System Continuity Test Data					
SBB		SBB with Panelboard Ground		SBB with Panelboard and Building Steel Ground	
Reference	Test (Difference)	Reference	Test (Difference)	Reference	Test (Difference)
Ω	Ω	Ω	Ω	Ω	Ω

END OF SECTION

PART 1 GENERAL

1.1 References

.1

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 communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Sustainable Design Submittals:

.1 Construction Waste Management:

.1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

.2 Submit Construction/Demolition Waste Management and Disposal in accordance with Section 01 74 21.

1.3 Delivery, Storage And Handling

.1 Deliver, store and handle materials in accordance 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect communication raceway systems from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.5 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 2-Post Telecom Rack

.1 EIA compliant 483mm 2-post telecom rack.

.2 Complete with double sided 10/32 tapped holes and EIA universal standard hole pattern.

.3 42 rack units 2.1m high complete with 2 hinged vertical cable management.

- .4 Floor mounted ultra heavy welded steel construction.
- .5 Black powder coat finish.
- .6 Acceptable manufacturers: Middle Atlantic, Electron Metal, Cable Talk

2.2 4-Post Equipment Rack

- .1 EIA compliant 19" equipment rack shall have a minimum of 42 useable rack spaces and a useable depth of 939mm.
- .2 Overall dimensions of rack shall be 1998mm H x 600mm W x 1086mm D
- .3 Shall have a 2300 lb. weight capacity or more.
- .4 Features:
 - .1 Constructed in 16-gauge steel.
 - .2 Meets PCI DSS (Payment Card Industry Data Security Standard)
 - .3 compliance requirements.
 - .4 Inside rear of cabinet includes two (2) toolless PDU cable trays for cable management and industry-standard vertical PDU installation.
 - .5 Cabinet doors feature a minimum 65% airflow perforation pattern that meets or exceeds equipment manufacturer requirements.
 - .6 Top panel is easily removable for cable installation. The generous cable access panels make it easy to install top panel without affecting installed cabling.
 - .7 Ships with doors and rails fully assembled ready for installation on-site. Side panels come packaged inside cabinet for on-site installation.
 - .8 Built in joining kit speeds up baying of multiple RB-DC cabinets within a row.
- .5 Specifications:
 - .1 One (1) locking front cabinet door with curved surface for added stability.
 - .2 One (1) locking pair of split rear cabinet door making access easier in tight spaces.
 - .3 Two (2) pairs of split, locking and removable side panels. Split panels are more versatile for removing.
 - .4 Two (2) pairs of 19in EIA-310-D compliant square hole punched rails with rack unit markings.
 - .1 Rails easily adjust in depth in 1/4" increments.
 - .2 Starter pack of (50) M6 screws, cage nuts and washers included.
 - .3 For 10-32 hardware see the CAGKIT Series.
 - .5 Two (2) tool less PDU cable tray.
 - .6 Six (6) hinged plastic cable grommets on top panel.
 - .7 One (1) removable top panel with numerous cable grommets.
 - .8 Four (4) adjustable leveling feet.
 - .9 Four (4) recessed casters allows for clearance through a standard height doorway.
 - .1 Casters can be removed.
 - .2 Casters are for moving an empty cabinet into place, not to support equipment load.
 - .10 Generous bonding locations provided on frame.
 - .11 Open Bottom

- .12 Fished in textured black powder paint
- .13 Tested to 2300 lbs of equipment load
- .14 Acceptable Product: Hammond RB-DC4242 with keylock complete with minimum 5 duplex receptacle power bar mounted vertical at the back of the rack, grommets, bonding kit, rear rail and fan, other manufacturer are Middle Atlantic, Electron Metal

2.3 Security Termination Blocks And Patch Panels

- .1 Riser Termination Blocks
 - .1 10 Connector mount to accommodate 250 pair Category 3 cables.
 - .2 Manufacturer recommended Management Rings.
 - .3 Shall utilize 25 Pair connector for copper building entrance cable and risers.
 - .4 Shall utilize designation strips, using machine printed labels in the colours designated in CSA-T528, for labelling of all connectors.
 - .5 Acceptable product: Belden A0270164, Cablek PNBIX-10A, ATI Cables TCBIX10A
- .2 Rack Mount Copper Patch Panels
 - .1 Copper Riser Patch Panel shall be keystone compliant to enable single port replacement vice replacing the entire patch panel should a port become unserviceable.
 - .2 Shall be 19 inch mountable
 - .3 Be able to accommodate a minimum of 48 keystone jacks.
 - .4 Be equipped with T568A Compliant 8 – pin RJ-45 keystone IDC connectors.
 - .5 IDC Category rating must meet or exceed cable category rating
 - .6 Be black in colour.
 - .7 Shall meet ANSI/TIA/EIA-568-A Category 6 channel compliancy requirements.
 - .8 Acceptable manufacturers:
 - .1 Panduit
 - .2 Belden/CDT
 - .3 Commscope/AMP
- .3 Rack Mount Fibre Optic Patch Panels
 - .1 Be 19 inch Rack mountable.
 - .2 Be able to accommodate a minimum of 96 keystone format ports.
 - .3 Be equipped with LC type bulkheads.
 - .4 Be equipped with front and rear hinged doors.
 - .5 Be equipped with cable strain relief; and.
 - .6 Be equipped with slack storage.
 - .7 Acceptable manufacturers:
 - .1 Panduit.
 - .2 Belden/CDT
 - .3 Tyco/AMP
- .4 Fibre Optic Connectors

- .1 Ceramic tipped field installed duplex 568LC connectors, which meet or exceed the performance specifications in ANSI/TIA/EIA-568-B.3.
- .2 Shall be have 50/125 Multi-Mode and 9/125 Single mode connectors as required.
- .3 Acceptable Manufacturers:
 - .1 Panduit.
 - .2 Belden/CDT
 - .3 Tyco/AMP

2.4 Communications Cable Management And Cable Tray

- .1 Rack - Vertical Management
 - .1 Made to run the full length of the rack;
 - .2 Made of steel
 - .3 Equipped with a hinged door.
 - .4 Be equipped with rear and side openings for transition of patch cables
 - .5 Shall be 254mm wide by 152mm deep and be powder coated black.
 - .6 Vertical cable management shall be black powder coated finish with hinged access panel.
 - .7 Acceptable manufacturer: Same as rack manufacturer.
- .2 Rack - Horizontal management
 - .1 Be made to run the full width of the rack
 - .2 Be made of steel
 - .3 Be equipped with a hinged door
 - .4 Be equipped with rear, top and bottom openings for transition of patch cables
 - .5 Be 2 rack unit or 4 rack unit; and
 - .6 Be black powder coat
 - .7 Acceptable Manufacturer: Same as rack manufacturer
- .3 Cable Tray for Communications Equipment Rooms
 - .1 Shall be a pre-fabricated structure, 400mm wide by 103mm tall and 300mm wide by 103mm tall consisting of a Basket bottom within basket two side rails.
 - .2 Shall be supported as per manufacturer's instruction and applicable codes.
 - .3 Proper manufactured fittings; accessories and fittings such as elbow, reducers, crossovers, tees and risers will be used for any change of direction, height or size of the basket cable tray.
 - .4 Acceptable Manufacturers: Cablofil, Cooper, T&B
- .4 Cable Tray Cable Drop-out or Waterfalls
 - .1 Provides 50mm bend radius
 - .2 Fits basket style cable tray. Easily attaches to wire basket by pressing onto wires
 - .3 Designed with durable Polyamide material.
 - .4 Acceptable Manufacturer: Same as ladder rack manufacturer

2.5 Communication Rack Mounted Power Protection And Power Strips

- .1 20 Amp Rack Mounted Vertical power bars

- .1 Shall be 20 amp, 120 volts.
- .2 Shall be switched.
- .3 Provide a minimum of two power bars per rack containing active equipment.
- .4 Complete with a minimum of 12 (12) outlets configured as NEMA (5-20R).
- .5 Complete with 1.8 m (6'-0") cord NEMA (L5-20P).
- .6 Acceptable manufacturer:
 - .1 Middle-Atlantic.
 - .2 Hammond.
 - .3 Wiremold.

2.6 Fire Rated Re-Enterable Cable Pass-Thru

- .1 The re-enterable cable pass-thru shall be Fire Rated Pathway is a pathway device designed to allow cables to penetrate firerated walls and floors without the need for firestopping.
- .2 The device shall be a built-in fire and smoke sealing system that automatically adjusts to the amount of cables installed. Once installed in a fire barrier, cables can be easily added or removed at any time without the need to remove or reinstall firestopping materials.
- .3 The re-enterable cable pass-thru Fire Rated Pathway shall consists of an enclosed heavy gauge galvanized steel pathway lined with intumescent material engineered for rapid expansion when exposed to fire or high temperatures, quickly sealing the pathway and preventing the passage of flames and smoke.
- .4 The re-enterable cable pass-thru Fire Rated Pathway shall be factory painted with safety orange for easy identification. Shall be compact square profile allows a maximum number of cables to be installed in a relatively small area.
- .5 The pathway shall measures approximately 102 x 118 x 356 mm and can be increased by 152mm using extension modules.
- .6 Cables may easily be added or removed at any time without removing or reinstalling the fire seal. Cables may be added individually or in bundles. Wrapping ends with a low-friction tape facilitates cable insertion. Avoid any sharp or exposed conductors that can potentially damage interior pads. A self-adjusting cable throat automatically adjusts to accommodate the cable bundle as it passes through the pathway. Installation of a pulling line will facilitate future cabling additions
- .7 The re-enterable cable pass-thru Fire Rated Pathway shall be UL Tested and Classified in accordance with ASTM E814 (UL1479) & CAN/ULC-S115. Systems are available for common floor and wall constructions with ratings up to and including 4 hours
- .8 All data, video, and communications cable bundles shall utilize an enclosed fire rated pathway device wherever said cables penetrate rated walls and floors. The fire-rated pathway shall contain a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479) & CAN/ULC-S115.
- .9 Acceptable Manufacturer: Wiremold, STI, Hilti, 3M

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 communication raceway systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .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 Installation of termination and cross-connect hardware
 - .1 Install termination and cross-connect hardware on wall and in rack as indicated and according to manufacturers' instructions. Identify and label as indicated to: TIA/EIA-606-A.
 - .2 Install consolidation points, as indicated according to manufacturer's instructions. Identify and label as indicated to: TIA/EIA-606-A.
- .2 Cable Tray
 - .1 Cable tray shall be installed above the rack supported from the ceiling and wall.
 - .2
 - .3 Please refer to the Canadian Electrical Code Part 1, 2018 for minimum cable tray clearances
 - .4 Support Cable Tray to suit loading and recommended support requirements in the Canadian Electrical Code, Part 1, for the applicable class. A Support shall be placed within a maximum of 610mm on either side of any connection to a fitting and 1524mm on centre as recommended by the cable tray manufacturer. Cable Tray shall be adequately fastened to withstand pulling tensions as per manufacturers recommendations.
 - .5 Remove any burrs, sharp edges, or projections that may damage cables.
 - .6 Install proper manufactured accessories and fittings such as elbows, reducers, crossovers, tees and risers for any change of direction, height or change of direction of the cable tray. Vented accessories shall be used.
 - .7 Install Cable tray either using angle brackets or trapeze, ensure only communications systems can be racked to the bottom of the tray. Electrical power or Mechanical controls shall not be racked or installed using communications equipment supports or hangers.
 - .8 Install Grounding and Bonding in accordance with section 27 05 26.
 - .9 Ensure other building components, i.e.: mechanical ducts, sprinkler pipes, luminaries, etc do not restrict access to Communications cable tray.
 - .10 Ground wire or bonding conductor for cable tray shall be installed outside the tray.

- .3 Rack
 - .1 Install rack as per rack manufacturer's recommendation.
 - .2 Ensure working space at the front and back of rack is as per CEC Part 1.
 - .3 Secure rack on the floor.
Provide grounding and bonding as per CEC.

3.3 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 Waste Management: separate waste materials for reuse, recycling in accordance with Section 01 74 21 - Construction/Demolition 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 pathways for communications systems installation.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No. 214-17, Communications Cables (Bi-National standard with UL 444).
 - .2 CSA-C22.2 No. 232-17, Optical Fiber Cables.
- .2 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA-568.0-D (2015), Generic Telecommunications Cabling for Customer Premises
 - .2 TIA-568.1-D (2015), Commercial Building Telecommunications Infrastructure Standard
 - .3 TIA-568.2-C (2009), Balanced Twisted Pair Telecommunications Cabling and Components Standards
 - .4 TIA-568.3-D (2016), Optical Fiber Cabling and Components Standard
 - .5 TIA- 606-B (2012), Administration Standard for Telecommunications Infrastructure
 - .6 TIA TSB-140-2004, Telecommunications Systems Bulletin - Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.
 - .7 TIA-598-D-2014, Optical Fiber Cable Colour Coding.

1.2 Definitions

- .1 Refer to TIA/EIA-598-D, Annex A for definitions of terms: optical-fiber interconnect, distribution, and breakout cables.

1.3 System Description

- .1 Structured communications wiring system consist of unshielded-twisted-pair and optical fibre cables, terminations, connectors, cross-connection hardware and related equipment installed inside building for occupant's radio, intercom, security data systems, including voice recording, access control and CCTV.

1.4 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 As-built Records and Drawings:
 - .1 Provide Microsoft Excel spread sheet reflecting cable installation and cross-connections.
 - .2 Provide electronic drawings in AutoCAD 2015 format depicting all construction.
 - .3 Provide two (2) bound complete hard-copy sets of as-built records to the Departmental Representative.
 - .1 Provide and place one hard copy of as-built records for each telecommunications room in plan holder in each telecommunications room.

1.5 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 Delivery, Storage And Handling

- .1 Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Coaxial Backbone Cabling

- .1 P3-750 75 Ohm impedance Jacket Color Black
- .2 Construction Materials
 - .1 Jacket Material: PE
 - .2 Center Conductor Material: Copper-clad aluminum
 - .3 Construction Type: Swaged
 - .4 Dielectric Material: Foam PE
 - .5 Outer Conductor Material: Aluminum
- .3 Dimensions
 - .1 Diameter Over Center Conductor, nominal: 4.242 mm
 - .2 Diameter Over Dielectric, nominal : 17.323 mm
 - .3 Diameter Over Outer Conductor, nominal: 19.050 mm
 - .4 Diameter Over Jacket, nominal: 20.828 mm
 - .5 Jacket Thickness, nominal: 0.8890 mm
 - .6 Outer Conductor Thickness, nominal: 0.8636 mm
 - .7 Cable Length: 762 m
 - .8 Shipping Weight: 260.00 lb/kft
- .4 Electrical Specifications
- .5 dc Resistance, Inner Conductor, nominal: 0.57 ohms/kft
- .6 dc Resistance, Outer Conductor, nominal: 0.19 ohms/kft
- .7 dc Resistance, Loop, nominal: 0.76 ohms/kft
- .8 dc Resistance Note: Nominal values based on a standard condition of 20 °C (68 °F)
- .9 Capacitance: 50.2 pF/m | 15.3 pF/ft
- .10 Capacitance Tolerance: ±1.0 pF/ft
- .11 Characteristic Impedance: 75 ohm
- .12 Characteristic Impedance Tolerance: ±2 ohm
- .13 Jacket Spark Test Voltage: 5000 Vac
- .14 Nominal Velocity of Propagation (NVP): 87 %
- .15 Operating Frequency Band: 1002–1218 MHz | 5–1002 MHz

- .16 Structural Return Loss: 30 dB @ 5–1002 MHz
- .17 Mechanical Specifications
- .18 Minimum Bend Radius, bonded: 152.40 mm
- .19 Pulling Tension, maximum: 306 kg

Electrical Performance

Frequency	Attenuation (dB/100 m)	Attenuation (dB/100 ft)
5 MHz	0.36	0.11
55 MHz	1.21	0.37
83 MHz	1.51	0.46
85 MHz	1.51	0.46
204 MHz	2.36	0.72
211 MHz	2.43	0.74
250 MHz	2.66	0.81
300 MHz	2.92	0.89
350 MHz	3.18	0.97
400 MHz	3.45	1.05
450 MHz	3.67	1.12
500 MHz	3.87	1.18
550 MHz	4.07	1.24
600 MHz	4.30	1.31
750 MHz	4.86	1.48
865 MHz	5.28	1.61
1000 MHz	5.71	1.74
1002 MHz	5.71	1.74
1218 MHz	6.40	1.95

** Attenuation listed represents maximum values at standard condition of 20 °C (68 °F)*

- .20 Shall be CSA certified as CMP per CSA Standard C22.2, no 214-94 if used in a plenum space as required by applicable building code the cable shall have a minimum rating of FT-6.
- .21 Acceptable Manufacturers, Belden, West Penn, Commscope, Carol

2.2 Backbone Amoured Optical-Fiber Cable

- .1 50/125 MICRON MULTI MODE INDOOR FIBRE OPTIC BACKBONE CABLING
 - .1 Indoor OM4 Distribution Tight Buffer 24 Fibers OFCP Aluminum Interlocked Armor Non-Unitized, 400M 10G, 150M 40G/100G Laser grade plenum rated fibre optic cable.
 - .2 Listed as Optical Fibre Conductive Plenum (OFCP) FT6 rated
 - .3 Sheath Colour: Violet
 - .4 Inner Sheet Colour: Erika Violet
 - .5 Inner Jacket Material: Polyvinyl Chloride
 - .6 Outer Jacket Material: Thermoplastic
 - .7 Strenght Member: Aramid Yarn
 - .8 Armor Type/Material: Interlocked Aluminum
 - .9 Overall Nominal Diameter: 0.631 in
 - .10 Maximum tensile strength during installation: 300 (1330)
 - .11 Maximum tensile strength during operation: 90 (400)
 - .12 Minimum bend radius; 10x the diameter of cable

- .13 Flexible 900 micron tight buffer
- .14 Optical Characteristics:
 - .1 Effective Modal Bandwidth (EMB): 4700/-
 - .2 Fiber Core Diameter: 50/125um
 - .3 Primary Coating Diameter: 250 micron
 - .4 Secondary Coating Diameter: 900 micron
 - .5 Max Attenuation at 1300 nm: 1.2 db
 - .6 Max Attenuation at 850 nm: 3.0 db
 - .7 Wavelength: 850/1300
 - .8 Ethernet Perform at 10 Gbit@Optical MM1: 400/-
 - .9 Ethernet Perform at 1 Gbit@Optical MM1: 1100/550
 - .10 Min Overfilled Launch (OFL) Bandwidth: 3500/500
- .15 Standards:
 - .1 UL Rating/Flame Test: Plenum
 - .2 CEC/C(UL) Specification: OFNP
 - .3 Telecommunications Standards: ANSI/ICEA S-83-596
 - .4 RoHS: Yes
- .16 Acceptable Manufacturers;
 - .1 Belden
 - .2 Tyco/AMP
 - .3 Panduit
- .2 9/125 MICRON SINGLE MODE INDOOR FIBRE OPTIC CABLE
 - .1 Laser grade Single mode 9/125 micron OS2 fibre optic cable.
 - .2 Listed as Optical Fibre Conductive Plenum (OFCP) FT6 rated
 - .3 Sheath Colour: Yellow
 - .4 Inner Sheet Colour: Yellow
 - .5 Inner Jacket Material: Polyvinyl Chloride
 - .6 Outer Jacket Material: Thermoplastic
 - .7 Armor Type/Material: Interlocked Aluminum
 - .8 Overall Nominal Diameter: 0.63 in
 - .9 Maximum tensile strength during installation: 300 (1330)
 - .10 Maximum tensile strength during operation: 90 (400)
 - .11 Minimum bend radius; 10x the diameter of cable
 - .12 Flexible 900 micron tight buffer
 - .13 Optical Characteristics:
 - .1 Effective Modal Bandwidth (EMB): 4700/-
 - .2 Fiber Core Diameter: 9/125um
 - .3 Primary Coating Diameter: 250 micron
 - .4 Secondary Coating Diameter: 900 micron
 - .5 Max Attenuation at 1300 nm: 0.5 db
 - .6 Max Attenuation at 1550 nm: 0.5 db
 - .7 Ethernet Perform at 10 Gbit@Optical MM1: 10/40 km

- .8 Ethernet Perform at 1 Gbit@Optical MM1: 5 km
- .14 Standards:
 - .1 UL Rating/Flame Test: Plenum
 - .2 CEC/C(UL) Specification: OFNP
 - .3 Telecommunications Standards: ANSI/ICEA S-83-596
 - .4 RoHS: Yes
- .15 Listed as Optical Fibre Conductive Plenum (OFCP)
- .16 Acceptable Manufacturers:
 - .1 Belden
 - .2 Tyco/AMP
 - .3 Panduit

2.3 Backbone Category 3 Indoor Cabling

- .1 Construction: 24 AWG solid copper
- .2 Shall meet or exceed ANSI/TIA/EIA 568-A and CSA T529 specifications for Category 3 Transmission Characteristics
- .3 Insulation Material: LS PVC - Low Smoke Polyvinyl Chloride
- .4 Outer Jacket Material: LS PVC - Low Smoke Polyvinyl Chloride
- .5 Mechanical Characteristics:
 - .1 Operating Temperature Range: -30°C To +60°C
 - .2 UL Temperature Rating: 60°C
 - .3 Bulk Cable Weight: 225 lbs/1000 ft.
 - .4 Max. Recommended Pulling Tension: 300 lbs.
 - .5 Min. Bend Radius/Minor Axis: 5.400 in.
 - .6 Min. Bend/Installation: 5.400 in.
- .6 Applicable Standards
 - .1 NEC/(UL) Specification: CMP
 - .2 CEC/C(UL) Specification: CMP
 - .3 EU Directive 2011/65/EU (ROHS II): Yes
 - .4 EU Directive 2000/53/EC (ELV): Yes
 - .5 EU Directive 2002/95/EC (RoHS): Yes
 - .6 EU RoHS Compliance Date (mm/dd/yyyy): 08/19/2005
 - .7 EU Directive 2002/96/EC (WEEE): Yes
 - .8 EU Directive 2003/11/EC (BFR): Yes
 - .9 CA Prop 65 (CJ for Wire & Cable): Yes
 - .10 MII Order #39 (China RoHS): Yes
 - .11 Other Specification: Meets Category 3 transmission performance requirements for multi-pair backbone cables as specified by TIA/EIA 568 B-2, including power-sum NEXT
- .7 Flame Test
 - .1 UL Flame Test: NFPA 262
 - .2 C(UL) Flame Test: FT6
- .8 Rated for 10Mb/s Ethernet, 4Mb/s Token Ring, and Voice Applications
- .9 Acceptable Products:

- .1 Belden
- .2 Coleman Cable
- .3 General Cable
- .4 Superior Essex

PART 3 EXECUTION

3.1 General Installation Requirements

- .1 Install all systems as per the CEC and manufacturers recommended installation procedures.
- .2 Label all faceplates cables and connectors in accordance with section 27 05 53.
- .3 Test cable in accordance with section 27 08 00.
- .4 Provide the following separation from Electrical Power systems installed in conduits:
 - .1 50mm from circuits of 300Volt and less.
 - .2 600mm from circuits 300Volt and higher.
 - .3 2 Metres from Circuits between 300V and 15KV.
 - .4 3 Metres for circuits above 15KV.
 - .5 Electrical systems cannot share the same pathway.

3.2 Installation Of Backbone Cables

- .1 Install backbone cables as indicated and according to manufacturers' instructions.
 - .1 Identify and label as indicated to: TIA/EIA-606-B.

3.3 Installation Of Equipment Cables

- .1 Install equipment cables from equipment patch panel, terminal strips as indicated.
 - .1 Identify and label as indicated to: TIA/EIA-606-B.

3.4 Implement Cross-Connections

- .1 Implement cross-connections using jumper wires, patch cords as specified.

3.5 Field Quality Control

- .1 Test backbone UTP cables as specified below and correct deficiencies: provide record of results as hard copy, electronic record on CD.
 - .1 Perform tests for Permanent Link on 4-pair cables:
 - .1 Category 6 using certified level III tester to: TIA/EIA-568.2-C.
 - .2 Perform Wire Map tests on multi-pair UTP cables to: TIA/EIA-568.1-D.
- .2 Test Optical-fiber strands for attenuation to: TIA/EIA-568.1-D and correct deficiencies: provide record of results as hard copy, electronic record on CD.
 - .1 Test horizontal links need at only one wavelength (850 nm or 1300 nm) and in one direction.
 - .1 Attenuation to be less than 2.0 dB, unless consolidation point is used.

- .2 If consolidation point is used, attenuation test result to be less than 2.75 dB when testing between horizontal cross-connect and telecommunications outlet/connector.
- .2 Test backbone links in both directions. Backbone links:
 - .1 Test multi-mode fibre at both applicable wavelengths (850 nm and 1300 nm).
 - .2 Test single-mode fibre at both applicable wavelengths (1550 nm and 1310 m).
- .3 Maximum attenuation: Cable attenuation + Connector loss + Splice loss.
 - .1 Multi-mode-fiber attenuation coefficients:
 - .1 3.5 db/km @ 850 nm; and
 - .2 1.5 db km @ 1300 nm
 - .2 Single-mode fibre attenuation coefficients at both 1310 nm and 1550 nm:
 - .1 1.0 db/km for inside plant cable; and
 - .2 0.5 db/km for outside plant cables.
 - .3 Maximum connector insertion loss: 0.75 db per pair and maximum splice insertion loss: 0.3 db.
- .3 Perform additional Tier 2 tests using optical time domain reflectometer (OTDR) on horizontal and backbone fibre pairs to: TSB-140.
 - .1 Correct deficiencies.
 - .2 Provide record of results as described in SUBMITTALS.
- .4 Provide record of results as hard copy, electronic record on CD to: TIA/TSB-140.

END OF SECTION

PART 1 GENERAL

1.1 Reference Standards

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No. 214-17, Communications Cables (Bi-National standard with UL 444).
 - .2 CSA-C22.2 No. 232-17, Optical Fiber Cables.
- .2 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA-568.0-D (2015), Generic Telecommunications Cabling for Customer Premises
 - .2 TIA-568.1-D (2015), Commercial Building Telecommunications Infrastructure Standard
 - .3 TIA-568.2-C (2009), Balanced Twisted Pair Telecommunications Cabling and Components Standards
 - .4 TIA-568.3-D (2016), Optical Fiber Cabling and Components Standard
 - .5 TIA- 606-B (2012), Administration Standard for Telecommunications Infrastructure
 - .6 TIA TSB-140-2004, Telecommunications Systems Bulletin - Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.
 - .7 TIA-598-D-2014, Optical Fiber Cable Colour Coding.

1.2 Definitions

- .1 Refer to TIA/EIA-598-D, Annex A for definitions of terms: optical-fiber interconnect, distribution, and breakout cables.

1.3 System Description

- .1 Structured communications wiring system consist of unshielded-twisted-pair and coaxial cables, terminations, connectors, cross-connection hardware and related equipment installed inside the building for occupant's radio, intercom, security data systems, including voice recording, access control and CATV.
- .2 Installed in physical star configuration with separate horizontal and backbone sub-systems.
 - .1 Horizontal cables link work areas or security device wiring inside the building to Server room 483 in 4th floor.
 - .2 Use category 6 cables for radio, intercom, IP access control and security data connections.

1.4 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 As-built Records and Drawings:
 - .1 Provide Microsoft Excel spread sheet reflecting cable installation and cross-connections.
 - .2 Provide electronic drawings in AutoCAD 2015 format depicting all construction.

- .3 Provide two (2) bound complete hard-copy sets of as-built records to the Departmental Representative.
- .1 Provide and place one hard copy of as-built records for each telecommunications room in plan holder in each telecommunications room.

1.5 **Quality Assurance**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 **Delivery, Storage And Handling**

- .1 Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 **Security Systems Horizontal Cabling**

- .1 Cabling shall meet or exceed category 6 requirement as per ANSI/TIA/EIA-568.2-C.
- .2 Shall be CSA certified as CMP per CSA Standard C22.2, no 214-94 if used in a plenum space as required by applicable building code the cable shall have a minimum rating of FT-6.
- .3 Characteristics shall meet the following specifications

Parameters	Performance @ 250Mhz
Attenuation (db/100 metre)	32.8
Next (db)	38.3
PSNext(db)	36.3
ACR(db)	5.5
PSACR(db)	3.5
ELFEXT(db)	19.8
PSELFEXT(db)	17.8
Return Loss (db)	17.3

- .4 Colour Purple for Security Systems.
- .5 Colour Blue for all other Systems.
- .6 Acceptable Manufacturers:
 - .1 Commscope/AMP 219567-Purple
 - .2 Belden 2413 007 A1000
 - .3 Panduit PUP6504VLUY

2.2 **Coaxial Horizontal Cabling**

- .1 RG 6/U 75 Ohm impedance 16 AWG copper clad steel 8.5 Db attenuation/30 metres @ 1000 Mhz, Colour White.

- .2 Shall be CSA certified as CMP per CSA Standard C22.2, no 214-94 if used in a plenum space as required by applicable building code the cable shall have a minimum rating of FT-6.
- .3 Acceptable Manufacturers, Belden, West Penn, Commscope, Carol

2.3 Coaxial Patch Cables

- .1 Site manufactured using snap and seal connectors and tested
- .2 Cut to size to provide a neat appearance.
- .3 Same manufacturer and type as coaxial cabling.

2.4 Coaxial Connectors

- .1 Snap-N-Seal precision BNC compression connectors.
- .2 Designed for applications using RG6 cable.
- .3 Designed for applications using RG6 quad shield cable.
- .4 High performance, 75 ohm Snap-N-Seal BNC Male connectors feature precision coaxial contacts for demanding bandwidth applications.
- .5 True 360 degree compression onto cable ensures optimum RF shielding performance, - 65dB effective shielding.
- .6 BNC Male Plug interface is designed to nominal Mil Spec C-39012 with 75 ohm characteristic impedance.
- .7 Integral silver-plated contact and Snap-N-Seal design ensures ease of installation and reliable, high frequency return loss performance of -30dB to 1 GHz.
- .8 Installation requires one-step 1/4" - 1/4" cable preparation and standard compression tools.

2.5 Faceplates And Connectors

- .1 Shall consist of a single gang faceplate that accepts 4 keystone modules.
- .2 Faceplate shall be sloped white in colour.
- .3 Shall allow for 4-Rj-45 jacks wired to T568-B scheme.
- .4 The outlets shall be an 8-pin modular, category 6, colour Red for Radio system, Green for Security data system, and White for voice pinned to ANSI/TIA/EIA 568B standard. Must fit into a keystone opening.
- .5 All other unused openings shall be blanked off.

2.6 Termination And Cross-Connection Hardware For Utp

- .1 IDC Terminal strips, 25 pair, for terminating 4 multi pair 100 Ohms balanced twisted pair cables and supporting cross-connections using jumper wires or compatible plug-ended patch cords: Category 3 to: TIA/EIA-568.2-C.
- .2 Mount or block for housing 12 IDC terminal strips, mounted on wall.
 - .1 Distribution rings or channels capable of externally mating with the above mount for managing cross-connection wires.
- .3 Patch panel, 2 rack units high, 48 ports:

- .1 Each port equipped with field installed "RJ-45" jacks, type Category 6 T568B to: TIA/EIA-568.2-C.
- .2 Horizontal cable-management unit for every 48 ports.

2.7 Utp Cross-Connect Wire

- .1 Category 3 1 pair to: TIA/EIA-568.2-C.

2.8 Utp Patch Cords

- .1 2, 3 and 5 metres long, with factory-installed male plug at both ends Category 6, 4 pairs to: TIA/EIA-568.2-C.

2.9 Utp Work Area Cords

- .1 3 metres long, each end equipped with "RJ-45" plug Category 6 to: TIA/EIA-568.2-C.

PART 3 EXECUTION

3.1 General Installation Requirements

- .1 Install all systems as per the CEC and manufacturers recommended installation procedures.
- .2 Label all faceplates cables and connectors in accordance with section 27 05 53.
- .3 Test cable in accordance with section 27 08 00.
- .4 Provide the following separation from Electrical Power systems installed in conduits:
 - .1 50mm from circuits of 300Volt and less.
 - .2 600mm from circuits 300Volt and higher.
 - .3 2 Metres from Circuits between 300V and 15KV.
 - .4 3 Metres for circuits above 15KV.
 - .5 Electrical systems cannot share the same pathway.

3.2 Unshielded Twisted Pair Cabling Installation

- .1 In order for unshielded twisted-pair cabling infrastructure to deliver high-speed performance, it is manufactured to very tight specifications. Consequently, to maintain the unshielded twisted-pair cabling system performance proper installation practices must be followed. Listed below are some requirements that shall be followed:
- .2 Never crush the cable, velcro ties shall be used as per manufacturer's recommendation.
- .3 Use of Velcro cable ties throughout the installation and in the telecom rooms is required.
- .4 Do not kink, knot or snag the cable while pulling, this will cause damage under the jacket and may alter cable performance.
- .5 Do not to exceed the recommended pulling tension.
- .6 Do not exceed the minimum bend of 4 x Outside Diameter (OD) for 4 pair UTP, 10 x OD for multi pair (more than 4 pair) UTP.
- .7 Per TIA/EIA 568-A never untwist the pairs of cable beyond the absolute minimum required for termination.

- .8 The cable jacket on UTP shall only be stripped back the minimum required to terminate to connecting hardware.
- .9 Cable management panels shall be used when terminating cable.
- .10 Use the same performance criteria for both cable and connecting hardware through the entire horizontal run.
- .11 Maximum cable lengths shall not be exceeded.
- .12 A maximum 40% fill ratio for all conduit runs.
- .13 All horizontal runs, moves, adds, and changes must be documented.
- .14 A single shared sheath at the outlet is not acceptable.
- .15 A cable radius drop out shall be installed from the ladder rack to the equipment rack or wall mounted BIX when transitioning category 6 cables to the patch panels or BIX.
- .16 Only one pin-out (Diagram 1) throughout the total installation (T568B) is allowed.
- .17 Install all cables through primary and secondary pathways. Unless otherwise specified, installation methods and techniques shall satisfy ANSI/EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .18 Where cables are supported from building structure they shall be adequately supported such that the cable will not be damaged by normal building use.
- .19 Horizontal station cables shall be home-run from the communication outlet box at the work area to the distribution frame serving the area as shown on the Drawings.
- .20 Cables shall not be installed or routed in any manner that violates the manufacturer's specifications. Manufacturer's minimum bend radius for static (post installation) cables is 10 times the cable diameter. Manufacturer's minimum bend radius for cables under strain (pulling tension) is 20 times the cable diameter.
- .21 Unless otherwise specified, terminate cables in accordance with ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, observing the industry standards for terminating colour-coded cables for premises and campus environments.
- .22 Do not install damaged or defective cable.
- .23 Installed damaged cable will not be accepted. Unless otherwise allowed by the Departmental Representative, damaged cable shall be removed and new cable installed at the expense of the Contractor. Damage includes physical damage to the cable and damage that may affect performance. THE DEPARTMENTAL REPRESENTATIVE WILL NOT ACCEPT CABLE OF ANY TYPE UNTIL AFTER IT IS INSTALLED AND PASSES A PHYSICAL INSPECTION AND ALL PERFORMANCE TESTS.
- .24 The Contractor shall field survey and review with the DEPARTMENTAL Representative similar installations on campus that contain the same type of materials that are used for this Project to gain the desired routing and layout, installation techniques, and finished-look prior to start of construction and as often as necessary during the construction process.
- .25 Cable Support Along Primary Pathway
 - .1 Primary pathways include major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.

- .2 Cables shall be routed to avoid cable crossover between cable continuing vertically floor-to-floor and cable routed horizontally.
- .3 Cable installation and cable routes shall be planned and cables shall be installed such that the capacity of the conduit, sleeves, and cable tray is used most efficiently.
- .4 Bundle and route cables throughout the building to maintain neat, uniform, and combed bundles. Where cable is exposed in vertical runs, such as utility shafts, provide reusable cable straps to neatly contain cable bundles.
- .5 Provide strain relief for cables routed vertically using mechanical fasteners such as conduit, C-channel, reusable cable straps, other necessary devices to support cables.
- .26 Cable Support Along Secondary Pathway
 - .1 Secondary pathways extend from the primary pathway to the communication outlet box. Secondary pathways carry cable from the primary pathway to the communication outlet box.
 - .2 Cable shall be routed parallel and perpendicular to walls and floor from the primary pathway to the outlet box. WHERE MULTIPLE ROUTES ARE POSSIBLE ROUTE CABLE ALONG THE SHORTEST ROUTE TO MINIMIZE CABLE LENGTH AS PRACTICABLE.
 - .3 Do not use suspended ceiling support hangers (wires) to support station cables.
 - .4 Do not support cable from other mechanical, electrical, or plumbing, systems.
 - .5 Station cables shall be supported such that they do not rest on the suspended ceiling system.
 - .6 Cables and cable pathways shall be supported from the building structure. Superstructure designed and intended to support multiple utilities may be used as a superstructure for communications cables if the superstructure can physically support the additional load and if the support mechanism for the cable works for supporting the cable from the superstructure.
- .27 Cable Bundling Hardware
 - .1 Cable bundling hardware shall be rated for the environment and application in which used. Applications include, but are not limited to, general purpose, outdoor, chemical resistant, flame retardant, high temperature, and vibration.
 - .2 Provide reusable cable management straps for bundling and securing horizontal station cables and equipment jumper cables within entrance facilities and telecommunication closets. Do not use nylon cable ties.
 - .3 Provide reusable cable management straps for bundling and securing horizontal station cables at primary vertical pathways. Do not use nylon cable ties.
 - .4 Do NOT strap horizontal station cable to cable tray and ladder rack.

3.3 Installation Of Termination And Cross-Connect Hardware

- .1 Install termination and cross-connect hardware on wall as indicated and according to manufacturers' instructions. Identify and label as indicated to: TIA/EIA-606-B.
- .2 Install consolidation points, as indicated according to manufacturer's instructions. Identify and label as indicated to: TIA/EIA-606-B.

3.4 Installation Of Horizontal Distribution Cables

- .1 Install horizontal cables as indicated in conduits and cable trays from telecommunication rooms to individual work-area jacks. Identify and label as indicated to: TIA/EIA-606-B.
- .2 Support horizontal cables at intervals not exceeding 1.5 metres.
 - .1 Where raceways are used to distribute cables to each zone, provide supplementary "J" hooks to support cables at intervals not exceeding 1.5 metres.

3.5 Installation Of Backbone Cables

- .1 Install backbone cables as indicated and according to manufacturers' instructions.
 - .1 Identify and label as indicated to: TIA/EIA-606-B.

3.6 Installation Of Equipment Cables

- .1 Install equipment cables from equipment patch panel, terminal strips as indicated.
 - .1 Identify and label as indicated to: TIA/EIA-606-B.

3.7 Implement Cross-Connections

- .1 Implement cross-connections using jumper wires, patch cords as specified.

3.8 Field Quality Control

- .1 Test horizontal UTP cables as specified below and correct deficiencies provide record of results as hard copy, electronic record on CD.
 - .1 Perform tests for Permanent Link on installed cables, including spares:
 - .1 Category 6 using certified level III tester to: TIA/EIA-568.2-C.
 - .2 Perform tests for Channel on 20 % of cross-connected data horizontal cabling installed from each telecommunications room, including shortest and longest drops from each telecommunications room: should more than 5 % of tested cables fail, test remaining cross-connected data cables.
 - .1 Category 6 using certified level III tester to: TIA/EIA-568.2-C.
- .2 Test backbone UTP cables as specified below and correct deficiencies: provide record of results as hard copy, electronic record on CD.
 - .1 Perform tests for Permanent Link on 4-pair cables:
 - .1 Category 6 using certified level III tester to: TIA/EIA-568.2-C.
 - .2 Perform Wire Map tests on multi-pair UTP cables to: TIA/EIA-568.1-D.
- .3 Test Optical-fiber strands for attenuation to: TIA/EIA-568.1-D and correct deficiencies: provide record of results as hard copy, electronic record on CD.
 - .1 Test horizontal links need at only one wavelength (850 nm or 1300 nm) and in one direction.
 - .1 Attenuation to be less than 2.0 dB, unless consolidation point is used.
 - .2 If consolidation point is used, attenuation test result to be less than 2.75 dB when testing between horizontal cross-connect and telecommunications outlet/connector.
 - .2 Test backbone links in both directions. Backbone links:
 - .1 Test multi-mode fibre at both applicable wavelengths (850 nm and 1300 nm).

- .2 Test single-mode fibre at both applicable wavelengths (1550 nm and 1310 nm).
- .3 Maximum attenuation: Cable attenuation + Connector loss + Splice loss.
 - .1 Multi-mode-fiber attenuation coefficients:
 - .1 3.5 db/km @ 850 nm; and
 - .2 1.5 db km @ 1300 nm
 - .2 Single-mode fibre attenuation coefficients at both 1310 nm and 1550 nm:
 - .1 1.0 db/km for inside plant cable; and
 - .2 0.5 db/km for outside plant cables.
 - .3 Maximum connector insertion loss: 0.75 db per pair and maximum splice insertion loss: 0.3 db.
- .4 Perform additional Tier 2 tests using optical time domain reflectometer (OTDR) on horizontal and backbone fibre pairs to: TSB-140.
 - .1 Correct deficiencies.
 - .2 Provide record of results as described in SUBMITTALS.
- .5 Provide record of results as hard copy, electronic record on CD to: TIA/TSB-140.

END OF SECTION

PART 1 GENERAL

1.1 System Description

- .1 Data Communications Network Hardware encompasses network equipment spanning multiple systems.

1.2 Submittals

- .1 Submit to Departmental Representative shop drawings, product data (including cut sheets and catalog information). Submit shop drawings, product data, and samples with such promptness and in such sequence as to cause no delay in the work or in the activities of separate Contractors. Consultant will indicate approval of shop drawings, and product data.
- .2 Provide factory service manuals Owners manuals and Factory provided cables not used for installation for all active equipment components with the O&M manuals.
- .3 Products selected for the project shall be of a single manufacturer throughout the various systems covered by different divisions.

PART 2 PRODUCTS

2.1 Network Switch (Security Network)

- .1 Shall be simple to install, manage and operate.
- .2 Shall supports secure management via IPv4 or IPv6 through features such as Secure Shell (SSHv1/2), Secure Sockets Layer (SSL), Simple Network Management Protocol (SNMPv1,2,3), IP Manager Lists, and administrative authentication via RADIUS or TACACS+ when connecting to the switch or stack.
- .3 Through support for IEEE 802.3at PoE+ which delivers up to 32 Watts of power per port to and devices, ERS 3500s are able to power IP phones, wireless LAN access points, networked high-definition CCTV cameras and other devices.
- .4 Shall have the have the added flexibility of converging video surveillance traffic over the network, since pan, tilt and zoom cameras are one of the end devices that require the additional power provided by PoE+.
- .5 Shall ensures investment protection for future end points, such as new Wireless LAN Access Points (3x3 802.11n access points and emerging 802.11ac access points) as well as next-generation video phones.
- .6 Shall classify, prioritizes and marks LAN IP traffic using up to four hardware queues on every port – including the rear SFP ports.
- .7 Classification can be based on MAC address, IP ToS/DSCP marking, IP source/destination address or subnets, TCP/UDP source/destination port/port range,

IEEE 802.1p user priority bits, ingress source port, IP Protocol ID (e.g., TCP, UDP, IGMP), EtherType (e.g., IP, IPX) or the IEEE 802.1Q VLAN ID. Comprehensive traffic policing and traffic shaping are also supported.

- .8 Shall be able to combine non-blocking internal switching fabrics with high-speed virtual backplane architecture for a high performance solution that scales proportionally as new switches are added.
- .9 Virtual hot swap, a critical serviceability and operability capability, helps ensure that failure in any stacked unit is quickly and easily rectified. Pioneered in modular switches, virtual hot swap is available in Avaya stackable chassis solutions where, without complex engineering, it enables immediate like-for-like unit replacement with no impact on other functionality and traffic, empowering operators to deploy our solutions just as they would a chassis. If a failure occurs, neighboring switches automatically wrap their fabric connections to help ensure that other switches in the stack are not impacted. The failed unit is simply disconnected from the fabric and, without pre-staging of software or configuration, a like unit is inserted, cabled, and powered-up. The Automatic Unit Replacement (AUR) process self-manages the software and configuration downloads to the new switch then brings it online, without the need for an engineer to manage the process.
- .10 Shall have a high level of security with authenticated network access that leverages IEEE 802.1X Extensible Authentication Protocol (EAP) with multiple extensions including support for Multi-Host Multi-Authentication mode (MHMA), Multi-Host Single-Authentication mode (MHSA), non EAP device support (i.e. printers, etc.) and RADIUS based MAC authentication support. Up to 32 host devices per switch port are supported in these modes.
- .11 24-Port Network Switch
 - .1 Switch Details:
 - .1 24 10/100Base-TX ports, plus 2 combo 10/100/1000BASE-T or SFP ports
 - .2 2 rear SFP ports can be used as additional ports in Standalone Mode, or, 2 rear HiStack ports delivering up to 10Gbps (FDX) of Stackable Chassis throughput per switch in Stacking Mode
 - .3 Fanless operation
 - .4 System CPU speed: 400MHz
 - .5 System memory: 32MB Flash, 128MB DRAM
 - .6 RJ-45 Console port provides industry standard serial port connectivity
 - .7 Switch capacity and forwarding rate (64-byte): 12.8Gbps / 9.5Mpps
 - .8 MTBF: 645,510 hrs
 - .2 Dimensions: Height: 1U or 44.5mm, Width: 440mm, Depth 280mm.
 - .3 Power and Thermal:
 - .1 Input voltage: 100 to 240 VAC@ 47 to 63 HZ
 - .2 Input current (max): 0.28A@100VAC
 - .3 Power consumption: 28.5 Watts max
 - .4 Thermal rating (output): 65 BTU/hr max

- .12 24 Port PoE+ Network Switch
 - .1 Switch Details:
 - .1 24 10/100BASE-TX ports with support for IEEE 802.3af PoE or IEEE 802.3at PoE+, plus 2 combo
 - .2 10/100/1000BASE-T or SFP ports
 - .3 2 rear SFP ports can be used as additional ports in Standalone Mode, or, 2 rear HiStack ports delivering up to 10Gbps (FDX) of Stackable Chassis throughput per switch in Stacking Mode
 - .4 System CPU speed: 400MHz
 - .5 System memory: 32MB Flash, 128MB DRAM
 - .6 RJ-45 Console port provides industry standard serial port connectivity
 - .7 Switch capacity and forwarding rate (64-byte): 12.8Gbps / 9.5Mpps
 - .8 MTBF: 332,778
 - .9 Dimensions: Height: 1U or 44.5mm, Width: 440mm , Depth 280mm
 - .10 Power and Thermal:
 - .11 Input voltage: 100 to 240 VAC@ 47 to 63 HZ
 - .12 Input current (max): 5.0A@100VAC
 - .13 Power consumption: 500Watts max
 - .14 Thermal rating (output): 360 BTU/hr max
 - .15 Maximum power budget: 370 Watts

PART 3 EXECUTION

3.1 General Installation Requirements

- .1 Install all systems as per the CEC and manufacturers recommended installation procedures.
- .2 Label all faceplates cables and connectors.
- .3 Use blank rack mount panels to cover un-used space in rack.
- .4 All cabling shall be contained in EMT Conduit
- .5 Provide hi quality factory manufactured patch cables from to phones and between patch cables to active equipment.
- .6 All Equipment shall be rack mounted with appropriate manufactured mounting equipment. All equipment contained in the rack shall use Velcro type fasteners and cable retaining bars for a neat and professional installation.
- .7 All exposed cables shall use an expanded material wiring loom to provide a professional appearance.

- .8 Provide all Programming of equipment and configuration. Provide copies of the software application and project specific files to the Consultant upon satisfactory completion of the project.
- .9 Provide the following separation from Electrical Power systems installed in conduits:
 - .1 50mm from circuits of 300Volt and less.
 - .2 600mm from circuits 300Volt and higher.
 - .3 2 Metres from Circuits between 300V and 15KV.
 - .4 3 Metres for circuits above 15KV.
 - .5 Electrical systems cannot share the same pathway.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)
 - .1 ANSI/TIA-569-C-2012, Telecommunications Pathways and Spaces
- .2 Building Industry Consulting Services International (BICSI)
 - .1 BICSI Telecommunications Distribution Methods Manual 13th Edition
- .3 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-12, Canadian Electrical Code

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 communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide factory service manuals Owners manuals and Factory provided cables not used for installation for all active equipment components with the O&M manuals.

PART 2 PRODUCTS

2.1 Wall Mount For Lcd Monitor

- .1 VESA compatibility: Sized as per display
- .2 Integrated teardrop design speeds up wall plate installation by allowing pre-installation of the bolts to the wall.
- .3 Centerless Shift provides up to 17.5" (445 mm) of post-installation lateral shift - 8.75" (222 mm) left/right of uprights - for limitless centering.
- .4 Centris low-profile tilt uses the center of gravity to balance the screen while maintaining a low profile.
- .5 Set screws keep the mount rigid, stable and secure throughout the life of the installation.
- .6 Click-Connect offers an audible click when the screen safely engages with the mount
- .7 Built-in cable stand provides easy access under the screen
- .8 A full line of accessories can be installed with the mount and the entire unit can be adjusted together.
- .9 Multiple installation options for various stud distances.
- .10 Exclusive nesting spacers can be stacked to achieve any depth.
- .11 Quick-Store Cords use magnets to easily store and access pull cords.

- .12 Improved cable management with new end caps
- .13 Integrated Security
- .14 Ships with a custom hardware kit that can be hung from mount rails if installing in stages
- .15 Tilt: +2° to -12°
- .16 To be compatible with the Departmental Representatives supplied LCD Monitor.

2.2 Ceiling Mount For Lcd Monitor

- .1 Ceiling mounts enable display installation from the ceiling on an extended pole that is adjustable in length to position the display at just the right height. The mounted displays can be adjusted in various vertical angles and the directional (horizontal) angle that the displays face can also be adjusted for optimal viewing. The ceiling mounts hold up to four times the weight of the supported display products.
- .2 Pole length: 1188 to 1588mm
- .3 Tilt angle: 20 degrees
- .4 Rotation angle: 360 degrees
- .5 To be compatible with the Departmental Representatives supplied LCD Monitor.

2.3 Shielded Category Cable

- .1 Shielded Twisted Pair Cable for HDBaseT
- .2 Key Features
 - .1 Engineered for superior performance.
 - .2 Provides added protection from outside interference and ensures high quality signal transmission.
 - .3 Certified to distances up to 70 m.
 - .4 Independently tested and verified to meet performance requirements set by HDBaseT Alliance.
 - .5 Engineered and tested to exceed HDMI error rate specifications of less than one pixel per billion at 100 meters
 - .6 SF/UTP design with four unshielded twisted pairs inside an overall braid and foil shield.
- .3 Shall be compatible with Matrix switcher scaler, wall plate HDMI, Serial and IR transmitter and receiver.
- .4 Acceptable Manufacturer: Crestron, Extron, Kramer

2.4 Matrix Switcher Scaler

- .1 The Matrix Switcher Scaler shall be a high-performance 11x4 presentation scaler/matrix switcher that can output four independent scaled images. Each output includes an HDMI and HDBaseT connector. The product shall support analog, digital and embedded audio.
- .2 The Matrix Switcher Scaler shall have six HDMI inputs, four HDBaseT inputs, an analog VGA input, and a 4x1 USB switcher. It shall also include a microphone input, independent stereo audio outputs, a monitor output, an amplified speaker output, and audio DSP features.

- .3 Shall have a precision pixel mapping and high-quality full up and downscaling technology
- .4 Shall be HDTV Compatible. HDCP Compliant
 - .1 Output Resolutions shall be up to 1080p/WUXGA
 - .2 The system range for the HDBT inputs and outputs to be up to 70m.
 - .3 The cables to be used shall provide optimum range and performance using HDBaseT™. Shall use manufacturer's recommended cable to obtain maximum performance and optimum distance range for devices.
 - .4 The 4x1 USB Switcher shall all the switcher to follow the switching of the video layer or as an independent switcher.
 - .5 Shall have an OSD (On Screen Display) for easy setup and adjustment, accessible via the front panel buttons
- .5 Audio DSP Features
 - .1 Input/Output Audio Level Adjustment
 - .2 Selectable Microphone Talk-over or Mix Modes
 - .3 Analog & Embedded Audio Support for inputs and outputs
 - .4 Built-in 2x10W power amplifier with speaker outputs on a 4pin terminal block connector
- .6 Multiple Aspect Ratio Selections
 - .1 Built-in ProcAmp Color, hue, sharpness, noise, contrast and brightness
 - .2 Built-in Web Pages for easy setup and remote control
 - .3 Firmware Upgrade via the Ethernet
 - .4 Multiple Control Options on front panel buttons with OSD, RS232, Ethernet and built-in Web pages
- .7 TECHNICAL SPECIFICATIONS
 - .1 INPUTS:
 - .1 6 HDMI connectors, 1 VGA on a 15pin HD connector, 4 HDBT on RJ45 connectors, 4 USB ports, 6 unbalanced analog audio on 3.5mm mini jacks for HDMI, 1 unbalanced analog audio on a 3.5mm mini jack for PC, 1 aux in/mic balanced stereo audio on a 5pin terminal block connector
- .8 OUTPUTS:
 - .1 4 HDBT on RJ45 connectors, 4 HDMI connectors, 1 USB port, 4 audio out balanced stereo on 5pin terminal block connectors, 4 audio out S/PDIF on RCA connectors, monitor out balanced stereo on a 5pin terminal block connector, monitor out S/PDIF on an RCA connector; 1 stereo speaker output, 2x10W into 4, on a 4pin terminal block connector
- .9 OUTPUT RESOLUTIONS:
 - .1 NATIVE, 640x480@60, 800x600@60, 1024x768@60, 1280x768@60,
 - .2 1360x768@60, 1280x720@60, 1280x800@60, 1280x1024@60, 1440x900@60,
 - .3 1400x1050@60, 1680x1050@60, 1600x1200@60, 1920x1080@60,
 - .4 1920x1200@60, 720x480p@60, 1280x720p@60, 1920x1080i@60,
 - .5 1920x1080p@60, 720x576p@60, 1280x720p@50, 1920x1080i@50, 1920x1080p@50
- .10 CONTROLS:

- .1 HDMI 1, HDMI 2, HDMI 3, HDMI 4, HDMI 5, HDMI 6, HDBT 1, HDBT 2, HDBT 3, HDBT 4, PC, USB 1, USB 2, USB 3, USB 4 input selector buttons; menu, enter, menu arrows, reset to XGA/720p, OSD SELECT, 2 RS232, Ethernet, line/mic selector switch, cond/dyn (48V) selector switch, mono/stereo selector switch, REM for muting audio
- .11 POWER CONSUMPTION: 100240V AC, 70VA max
- .12 OPERATING TEMPERATURE: 0° to +40°C (32° to 104°F)
- .13 STORAGE TEMPERATURE: 40° to +70°C (40° to 158°F)
- .14 HUMIDITY: 10% to 90%, RHL noncondensing
- .15 PRODUCT DIMENSION: 2U, 43.6cm x 36.50cm 8.80cm W, D, H
- .16 Shall include rack mounting hardware.
- .17 Acceptable Manufacturer: Crestron, Extron, Kramer

2.5 Touch Screen Control Panel

- .1 The Control Panel shall be user-friendly cloudbased platform for designing advanced room control systems from any iOS or Android touch device. The software platform shall be able to easily design the control and automation for room elements such as lights, screens, sound, HVAC, thermostats, and any new or existing AV system. In the Cloud, users or technicians can easily share and collaborate with their team during the design phase. They can also provide remote support, updates and maintenance to customers, reducing the need for onsite visits.
- .2 The control panel software shall be BYOD Friendly and shall be supported on most commercially available iOS and Android touch devices and can be easily downloaded for free on the App Store and Google Play
- .3 Shall be Cloud-Based Platform design (for Admin and Build phases) and runs on any Web browser. No installation is required. The software shall allow the control system designers collaborate easily with their team and install finished designs on a touch device with a single click. Installations shall be edited, modified and supported via the Cloud, reducing the need to travel to install sites
- .4 The software shall be a Drag & Drop Control Program Configuration to speed up the configuration: slider widgets, modules for Vera™ automation, Centralite lighting, and cameras; IPcontrolled Apple TV and fullscreen immersive mode support (in version 3.1)
- .5 Shall have serial and IR control connectivity and iPhone 6/6+ panels.
- .6 Shall have predesigned graphical user interfaces that enable complex control of advanced room automation systems with no additional programming required. Modules shall include support for lighting, automation, security, HVAC, sound systems and VIA Wireless Collaboration Solutions
- .7 Shall have a fully-automated room control solutions, support for multidevice feedback, global variables, and conditional phrases
- .8 Shall be Highly Scalable that can be designed for one projector or an entire "smart" office. Virtual button panels can contain hundreds of buttons to cover any possible control need in largescale deployments
- .9 Shall be able to be installed on any commercially available touch device, eliminating the need to purchase dedicated hardware. The Cloudbased design platform allows for remote support and updates, reducing the need for onsite visits, and saving time and money

- .10 Shall be a complete control and automation system design platform. Users can natively control Ethernet-enabled devices. Devices with RS232, GPIO, relays, or IR support can be controlled over Ethernet or third-party controllers. The control button controllers can be mixed in to any project to provide tactile operation.
- .11 Shall be complete with software licenses.
- .12 Acceptable Manufacturer: Crestron, Extron, Kramer

2.6 Hdmi, Serial And Ir - Transmitter And Receiver Over Twisted Pair Cable

- .1 The transmitter and receiver shall be a high performance, HDBaseT twisted pair wall plate transmitter for 4K@60Hz (4:2:0) HDMI, RS232 and IR signals. The transmitter and receiver shall inputs the signals and converts them into an HDBaseT twisted pair signal that it transmits to a receiver. The it shall be supplied with a Midway Size 2 gang DECORA® design frame
- .2 Features:
 - .1 Max. Data Rate - 10.2Gbps (3.4Gbps per graphic channel)
 - .2 HDTV Compatible
 - .3 HDCP Compliance
 - .4 HDBaseT™ Technology
 - .5 HDMI Support - Deep Color, x.v.Color™, Lip Sync, HDMI Uncompressed Audio Channels, Dolby TrueHD, DTSHD, CEC
 - .6 3D Pass-Through
 - .7 EDID PassThru - Passes EDID signals between the source and display
 - .8 2K & 4K Support
 - .9 System Range - Up to 70m (230ft)
 - .10 Cable - For optimum range and performance using HDBaseT™, use manufacturer's recommended cable to obtain optimum performance and distance range.
 - .11 Indicators - Status LEDs for input, output, link and power
 - .12 Dimensions - 12.4cm x 3.12cm x 7.9cm (W, D, H)
- .3 TECHNICAL SPECIFICATIONS
 - .1 INPUTS: 1 HDMI connector
 - .2 OUTPUTS: 1 HDBaseT twisted pair RJ45 connector
 - .3 BANDWIDTH: 10.2Gbps (3.4Gbps per graphic channel)
 - .4 RS-232 BAUD RATE: 115200
 - .5 COMPLIANCE WITH
 - .6 HDMI STANDARD:
 - .7 Supports HDMI and HDCP
 - .8 POWER CONSUMPTION: 5V DC, 360mA
- .4 Acceptable Manufacturer: Crestron, Extron, Kramer

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 communication raceway systems 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 The matrix switcher shall be controlled using the 10" touch screen panel located in the podium. On the touch screen panel there shall be icons for each monitor, once a monitor icon is selected there shall be several sub-icons indicating the following options;
 - .1 On and Off button for the monitor
 - .2 Monitor Input selector
 - .3 Volume Control
- .2 There shall be an icon to turn On or Off all the monitors and turn On or Off the matrix switcher.
- .3 There shall be an icon for selecting an individual input to several output device.
- .4 There shall be an icon for selecting an individual input to an individual output device.
- .5 Install all systems as per the CEC and manufacturers recommended installation procedures.
- .6 Contractor to provide sample GUI for approval by the Departmental Representative.

3.3 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.

3.4 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by pathways for communications systems installation.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 ASTM E1374-06 (11) – Standard Guide for Open Office Acoustics and Applicable ASTM Standards
- .2 ASTM E1573-09 – Standard Test Method for Evaluating Masking Sound in Open Office Using A-Weighted and One-Third Octave Band Sound Pressure Levels
- .3 ASTM E1130-08 – Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index
- .4 ASTM E2638 – Standard Test Method for Objective Measurement of Speech Privacy Provide by Closed Rooms
- .5 Acoustical Design of Conventional Open Plan Offices, Canadian Acoustics, vol 27, no. 3, 2003 (NRCC-46274)
- .6 UL6500 - Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial and Similar General Use

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 Sound Masking systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Include single line diagram, sound masking speaker layout of complete Sound Masking system including cable types and size.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan in accordance with Section 01 74 21 Construction/Demolition Waste Management and Disposal.

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 Sound Masking systems for incorporation into manual.
- .3 Include parts list using component identification numbers standard to electronics industry.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address. Inspect manufacturer's packages upon receipt.
- .2 Storage and Handling Requirements:

- .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect Sound Masking systems from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Protect from moisture during shipping, storage and handling.
- .5 Handle packages carefully.
- .3 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

1.5 Performance Requirements

- .1 General Performance
 - .1 The intent of this specification is to provide an I.P. network based sound masking and paging system having the ability to control each and every speaker individually. Systems having two or more speakers on an individual speaker channel, or network address, are not acceptable.
 - .2 The entire sound masking and paging system shall be controllable from an attached computer. Windows based software shall be provided.
 - .3 Network speaker controllers shall be PoE having networked audio and electrical power distributed in a single CAT-5 cable. Controllers shall be PoE IEEE 802.3af-2003 compliant.
 - .4 The basic system configuration shall provide eight (8) networked digital audio streams which can be delivered, in any combination, to any individual speaker or selected groups of speakers. Optionally the system shall be capable of expansion of up to 32 networked audio channels.
 - .5 The basic system configuration shall provide dual channel, non-coherent soundmasking for alternating networked speakers.
 - .6 The system shall provide accommodation for the integration of existing, or future, 70.7 volt amplifiers and speaker arrays for use in the creation of hybrid systems having traditional 70.7 volt zones as well as IP addressable speaker zones under the same software control.
- .2 Sound Masking Performance
 - .1 The system shall use DSP technology for sound masking generation and equalization of the sound masking signals.
 - .2 All sound masking generators shall incorporate 1/3 octave band equalization from 125 Hz. to 10000 Hz. Each generator shall also incorporate a dedicated high pass and low pass filter with configurable slope.
 - .3 Each rack mounted, centrally located soundmasking generator shall incorporate four non-coherent sound masking generators for network broadcast.
 - .4 Each speaker controller shall incorporate four internal non-coherent soundmasking generators as well as the ability to receive networked sound masking broadcasts.

- .5 The masking volume shall be digitally adjustable in 0.5 dBA increments over a range of 35 dBA to 85 dBA @ 1m.
- .3 Paging Performance
 - .1 The system shall use DSP technology for equalization of the paging signals.
 - .2 The analog page interface shall accept eight (8) balanced line-level audio inputs and provide octave band equalization and compression for each input.
 - .3 The paging volume shall be digitally adjustable in 0.5 dBA increments over a range of 35 dBA to 85 dBA @ 1m.
- .4 Automatic Level Control
 - .1 The system shall provide a timer function allowing network audio levels to be automatically controlled according to a calendar-based user defined schedule.
 - .2 The system shall provide automatic daylight saving time adjustments.
 - .3 The system shall provide a transition process that automatically increases the masking volume over a period of time according to a programmed schedule.
 - .4 The system shall allow for up to four independent timer zones per programmable timer.
 - .5 The system shall allow independent timer schedules for each day of the week.
 - .6 The system shall allow user defined rates of volume adjustment and attenuation levels.
- .5 Network Performance
 - .1 All network switches shall be industry standard PoE IEEE 802.3af-2003 compliant switches such as those manufactured by Netgear, Cisco, LynkSys or other manufacturers of standard network equipment. Proprietary network topology is not acceptable.
 - .2 The system shall be capable of ensuring that the expected network devices are present and communicating properly and identification of network devices that are not communicating properly.
 - .3 The network control software shall be capable of monitoring and displaying the current settings for all network devices and speakers.
 - .4 The system shall be capable of generating detailed reports of all system settings down to the level of individual network devices and speakers.
 - .5 Each network speaker controller shall have eight (8) speaker outputs.
 - .6 Speaker controllers shall be capable of equalization, level adjustment and network audio channel selection for every individual speaker.

1.6 Submittals

- .1 Product Data: Manufacturer's specifications and installation instructions
- .2 Network Design: Schematics of the network showing quantity and location of network components and related cabling

- .3 Warranty Documents: Warranty documents covering the system components.

1.7 Quality Assurance

- .1 Manufacturer Qualifications: Minimum of 10 years manufacturing sound masking systems.
- .2 Installer Qualifications: Approved by manufacturer representative and are trained with the specified products or have demonstrated experience with the installation of similar products.
- .3 Uses industry standard network switches and cabling and methodology.

1.8 Delivery, Storage And Handling

- .1 Protect from moisture during shipping, storage and handling.
- .2 Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.
- .3 Inspect manufacturer's packages upon receipt.
- .4 Handle packages carefully.

1.9 Warranty And Maintenance

- .1 Provide a written warranty that products installed shall be free from defects in parts or assembly for a 5-year period from date of installation.

PART 2 PRODUCTS

2.1 Manufacturers

- .1 Networked sound masking systems meeting the addressability criteria may be substituted. Systems utilizing primary and secondary network devices where the secondary device is not individually controllable are not acceptable. Systems having more than one speaker connected to a speaker channel are not acceptable.

2.2 System Components

General System Overview: The sound masking and paging system shall be a PoE networked system with eight digital network audio channels. The system shall be comprised of:

- .1 rack mounted sound masking/paging/music processors
- .2 overhead or plenum mounted network speaker controllers
- .3 rack mounted programmable level controller
- .4 loudspeaker assemblies

- .5 PoE network switches
- .6 cable assemblies

.1 Each rack mounted sound masking / paging / music DSP shall provide:

- .1 Four (4) ea. DSP sound masking generators
- .2 Four (4) ea. DSP 1/3 octave band equalizers for sound masking
- .3 Four (4) ea. DSP configurable low pass and high pass filters
- .4 Eight (8) ea. balanced line level inputs via rear mounted pluggable connectors
- .5 Eight (8) ea. DSP one octave band input equalizers
- .6 Eight (8) ea. DSP input compressors
- .7 Eight (8) ea. balanced line level outputs via rear mounted pluggable connectors
- .8 Eight (8) ea. network digital audio output channels
- .9 Eight (8) ea. balanced analog output channels (for connection to 70.7 volt systems)
- .10 Twelve input by eight output (12x8) DSP matrix mixer
- .11 Dimensions: Width 19.0 inches Height 1.75 inches; 1 RU
- .12 Network communication components
- .13 Device shall be ETL listed to conform to UL60065

.2 Each speaker controller shall provide:

- .1 Four (4) ea. DSP sound masking generators
- .2 Four (4) ea. DSP 1/3 octave band equalizers for sound masking
- .3 Four (4) ea. DSP configurable low pass and high pass filters for sound masking
- .4 Eight (8) ea. digital network audio inputs
- .5 Eight (8) ea. DSP one octave band equalizers
- .6 Eight (8) ea. speaker output channels
- .7 A twelve input by eight output (12x8) DSP matrix mixer
- .8 PoE network communication components
- .9 Dimensions: height: 1.5", width 5", length 8"
- .10 Device shall be ETL listed to conform to UL60065, UL2043

.3 Each speaker assembly shall provide:

- .1 A connection to the speaker controller with strain relief
- .2 An acoustically damped enclosure
- .3 Eye-bolt for single point suspension and upward facing speaker orientation
- .4 Overall dimensions: Diameter 8.5" (21.6 cm), Height 4.8" (12.4 cm)
- .5 Speaker diameter: 6.0 inches
- .6 Speaker sensitivity: 90 dBA@1Watt, 1 meter pink noise

- .7 Speaker power rating: 10 watts RMS
- .8 Speaker frequency response: 100-10,000 Hz
- .9 Magnet size: 20 oz.
- .10 Speaker impedance: 8 ohms
- .11 Device shall be ETL listed to conform to UL1480, UL2043, CSA C22.2 60065

.4 Cable assemblies:

- .1 Provide power, audio and control signals over standard plenum rated CAT-5 with RJ-45 connectors.
- .2 Provide speaker connections to speaker controllers with two conductors, 18 A.W.G. copper stranded, plenum rated wire.

.5 PoE network switches shall be:

- .1 Professional or commercial quality PoE IEEE 802.3af-2003 compliant network switches as required. CAT-5 with RJ-45 connectors. Typical switch: 24 port PoE

2.3 Software Control

.1 The Windows® PC based software shall provide:

- .1 The ability to adjust any individual speaker without affecting adjacent speakers
- .2 The ability to define and adjust groups of speakers
- .3 Sound masking volume and equalization
- .4 Paging volume and equalization
- .5 The ability to route any mix of eight network audio channels to any individual speaker
- .6 The ability to create and adjust zones for paging and music
- .7 Reporting of all system settings
- .8 Backup and restore functions for all system settings
- .9 Network diagnostics

- .2 In addition to the provided software, all system functions shall be controllable via SNMP (simple network management protocol) to facilitate integration into other building control systems or end user systems

PART 3 EXECUTION

3.1 Network Design

- .1 Design network according to manufacturer's specifications.

3.2 Site Conditions

- .1 Verify facility conditions are suitable for the system installation.
- .2 Verify the facility is constructed according to plans including wall locations, ceiling types, plenum barriers and plenum heights.
- .3 Ensure sufficient space and power for centrally located components is available as per plan and manufacturer's specifications.

3.3 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for intercommunications systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of .
 - .2 Inform of unacceptable conditions immediately upon discovery.
 - .3 Ensure that facility build out is at a stage suitable for the system installation.
 - .4 Ensure that facility is constructed according to plans, including wall locations, ceiling types and plenum barriers.
 - .5 Ensure that the plenum height is appropriate as per manufacturer's recommendations and as per plan.
 - .6 Ensure power requirements have been provided as per plan.
 - .7 Ensure sufficient space for centrally located components is available as per plan and manufacturer's specifications.
 - .8 Ensure any third-party components required to be interfaced with the system have been provided.
 - .9 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from .

3.4 Permits

- .1 Obtain necessary permits for installation work.

3.5 Installation

- .1 Follow all applicable codes for the area.
- .2 Follow the system design for location of speaker controllers, speakers and wiring.
- .3 Record any necessary changes to the system design on the plan

3.6 Field Quality Control

- .1 Ensure that distance between the top of the loudspeaker and the deck meets manufacturer's minimum specifications
- .2 Ensure that loudspeakers are not obstructed

- .3 Ensure cables are properly supported and securely terminated

3.7 Network Configuration And Adjustment

- .1 Follow manufacturer's recommendations for system settings as found in the Privacy Manager User Manual.

3.8 Testing And Reporting

- .1 Test covered areas for desired spectrum and spatial uniformity
- .2 Verify that all system audio functions and timers are correctly configured per plan

3.9 As-Builts And Documentation

- .1 Provide detailed drawings showing all speaker controllers and speaker Identifications
- .2 Provide a printed report detailing system settings
- .3 Provide all instruction and installation documents.
- .4 Provide all close-out and warranty information.

3.10 Demonstration And Training

- .1 Demonstrate operational system to the Departmental Representative by walking the space.
- .2 Demonstrate functionality of the system to the Departmental Representative.
- .3 Provide any training to the Departmental Representative that may be required under the terms of the contract to maintain and/or operate the system or any optional devices (e.g., in room controls)
- .4 Provide 2 hour training for users and 2 hour training for maintenance personnel.

3.11 Tests

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conduct intelligibility performance test.

3.12 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 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.13 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by intercommunications and program systems installation.

END OF SECTION

PART 1 GENERAL

1.1 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 intercommunications systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Include riser diagram, talk paths of complete intercom system.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan and Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75 % of construction wastes were recycled or salvaged.

1.2 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for intercommunications systems for incorporation into manual.
- .3 Include parts list using component identification numbers standard to electronics industry.
- .4 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

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 indoors, off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect intercommunications systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 Materials

- .1 Conduits: type EMT, size as indicated, in accordance with Section 27 05 28 – Pathways for Communications.

- .2 Communication conductors: type category 6

2.2 Video Master Stations

- .1 The Intercom system shall be SIP-based intercom stations compatible with a variety of SIP servers (Cisco, Avaya, Asterisk and Genetec)*
- .2 Shall be able to Integrate with TOA N-8000 Intercom via N-8000SG SIP Gateway
- .3 Shall have Peer-to-peer communication with unlimited stations
- .4 Shall provide provide video conference capability, Multi-cast transmission enables paging to multiple zones.
- .5 Shall be Android based for easy customization. Compatible with major video codecs.
- .6 PoE or local power
- .7 Key Features:
 - .1 AEC, Noise canceller for noise free, intelligible conversations
 - .2 Speech Quality is up-to 7kHz Audio
 - .3 2M pixel Camera built-in, a photosensor turns on InfraRed light for capturing pictures in darkness
 - .4 H.263, H.264 for Video Codec, and G.711a/μ, G.722, G.729 for Audio Codec
 - .5 PoE (IEEE802.3af, Power Over Ethernet) is supported
 - .6 Supported network protocols are HTTP, HTTPS, FTP, DNS, NTP, RTSP, RTP, ICMP, DHCP, ARP
 - .7 Supported Network Security are SIP over TLS, HTTPS, SRTP (encryption of streaming)
 - .8 Unlimited number of stations are available in one system by using Peer-to-peer mode
 - .9 Address book can store up to 3000 names
 - .10 System configuration, control and monitoring via web browser
 - .11 Specifications
 - .1 Phone Features
 - .1 Web support multi-language
 - .2 Auto-answer
 - .3 Volume control
 - .4 Direct IP call without SIP proxy
 - .5 Auto-Provision
 - .6 DTMF modes: Inband, RFC2833, SIP INFO
 - .7 Audio Features: VAD, CNG, AEC, G.165/G.168
 - .2 Network Features
 - .1 2x10/100Mbps Ethernet Port
 - .2 1xPoE(IEEE803.2af)
 - .3 Security: Password Protection, IP address filtering, SIP over TLS, HTTPS encryption, user access log
 - .4 Protocols support: IPv4, HTTP, HTTPS, FTP, DNS, NTP, RTSP, RTP, TCP, UDP, ICMP, DHCP, ARP
 - .5 IP assignment: Static IP, DHCP, PPPoE
 - .3 SIP Features

- .1 SIP v1(RFC2543), SIP v2(RFC3261)
- .2 Audio codecs: G.711a, G.711μ, G.722, G.723, G.729a/b, iLBC, AMR-NB/WB, OPUS
- .3 Video codecs: H.263, H.264
- .4 Speech Quality: 7kHz Audio
- .5 Echo Cancellation
- .6 Voice Activation Detection
- .7 Comfort Noise Generator
- .4 Others
 - .1 Android 4.2
 - .2 Management by LCD Menu Configuration, WebUI
 - .3 Download content from the specified server
 - .4 Information receiving, storing, and rendering capabilities
 - .5 Web browser
 - .6 Contacts and Call records management
 - .7 Support playing local or online video
- .5 Graphic Display: 7 inch capacitive touch screen TFT LCD, 800x480 pixels , 16:9 wide screen aspect ratio
- .6 Camera 2M pixels C-MOS camera, free rotation
- .7 Resolution up to 1080p
- .8 Video Features:
 - .1 QCIF, QVGA, CIF, 4CIF, VGA
 - .2 Video bitrate: 64kbps~2Mbps
 - .3 PIP
 - .4 Full Screen
 - .5 local video ON/OFF control
- .9 Hands-Free: Microphone and Speaker built-in
- .10 Hand-set: Connected with a carl-cord
- .11 External Interface: IEEE802.11 b/g/n, USB 2.0, 3.5mm headset jack, HDMI
- .12 Power Source: DC 12V by AC adaptor, PoE
- .13 Power Consumption: less than 12W
- .14 Installation: Desktop
- .15 Operating Temperature: 0°C 40°C
- .16 Finish: ABS
- .17 Dimension: 240(H)x213(W)x120(D)mm

2.3 Video Door Stations

- .1 Shall be compatible with major audio codecs
- .2 Shall have a Built-in AEC (Acoustic Echo Canceller) enables full-duplex communication
- .3 Shall have a Photo Sensitive Sensor that detects brightness
- .4 Shall have IR LEDs help to capture video even in dark environments

- .5 Shall have camera resolution up to 1080p.
- .6 Key Features
 - .1 AEC, Noise canceller for noise free, intelligible conversations
 - .2 Speech Quality is up-to 7kHz Audio
 - .3 3M pixel Camera built-in, a photosensor turns on InfraRed light for capturing pictures in darkness
 - .4 H.264 MPEG-4, MJPEG for Video Codec, and G.711a/μ, G.722, G.729 for Audio Codec
 - .5 PoE (IEEE802.3af, Power Over Ethernet) is supported
 - .6 Supported network protocols are HTTP, HTTPS, FTP, SNMP, DNS, NTP, RTSP, RTP, ICMP, DHCP, ARP
 - .7 Supported Network Security are SIP over TLS, HTTPS, SRTP (encryption of streaming)
 - .8 Unlimited number of stations are available in one system by using Peer-to-peer mode
 - .9 In addition to the call button, the door station has two control inputs, and 2 relay outputs for interface to access control, etc.
 - .10 System configuration, control and monitoring via web browser
- .7 Specification
 - .1 Phone Features
 - .1 Web support multi-language
 - .2 Auto-answer
 - .3 Volume control
 - .4 Direct IP call without SIP proxy
 - .5 Auto-Provision
 - .2 Network Features
 - .1 2x10/100Mbps Ethernet Port
 - .2 Security: Password Protection, IP address filtering, SIP over TLS, HTTPS encryption, user access log
 - .3 Protocols support: IPv4, HTTP, HTTPS, FTP, SNMP, DNS, NTP, RTSP, RTP, TCP, UDP, ICMP, DHCP, ARP
 - .3 SIP Features
 - .1 SIP v1(RFC2543), SIP v2(RFC3261)
 - .2 Audio codecs: G.711a, G.711μ, G.722, G.729
 - .3 Video codecs: H.264 MPEG-4/MJEG (E21V only)
 - .4 Speech Quality: 7kHz Audio
 - .5 Echo Cancellation
 - .6 Voice Activation Detection
 - .7 Comfort Noise Generator
 - .4 Switches: 1 Call button, 1 reset button (on board)
 - .5 Microphone: 1 integrated microphone, IP67
 - .6 Speaker: 1W, IP66
 - .7 Control Input: 2 input relays for alarm/ (Voltage, Current)
 - .8 Control Output: 2 output relays for door opener/ (Voltage, Current)
 - .9 Indication Status: lamp (colors: red, green, blue)

- .10 Power Source: 12V DC
- .11 Power Consumption: less than 12W
- .12 IP Grade: IP65
- .13 Installation: Flush-mounted, Fit in Clipsal 164/4 back box
- .14 Operating Temperature: -20°C 55°C
- .15 Finish Plate: Stainless steel
- .16 Dimension 210(H)x120(W)x45.6(D)mm

2.4 Power Supply

- .1 Power supply unit, electric door strike, well filtered, regulated, constant voltage under load.
 - .1 Output: 12/24 V DC at 5A.
 - .2 Input: 110-120 V, 60 Hz.
 - .3 Fuse: replaceable.
 - .4 Rectifier: silicon full wave bridge.
 - .5 Filter, choke and dual capacitors.
 - .6 Hook-up, (+) (-) terminal strip with terminal screws.
 - .7 Line cord: 2 m, 3 conductor with specially constructed strain relief.
 - .8 Housing: metal case.

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 intercommunications systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 Installation

- .1 Install equipment as indicated and in accordance with manufacturer's instructions.
- .2 Interconnect system components.

3.3 Tests

- .1 Conduct intelligibility, visual and performance test.

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 Waste Management: separate waste materials for reuse, recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by intercommunications and program systems installation.

END OF SECTION

PART 1 GENERAL

1.1 System Description

- .1 The penetrating fire stop devices are required for wall penetrations for telecommunications cable tray penetrations through walls throughout the project.
- .2 All firestopping for entire project shall be from a single contractor experienced in firestopping and holding a membership with the Firestop Contractor International Association (FCIA).
- .3 All firestopping products shall be from a single manufacturer.

1.2 Submittals

- .1 Submit to the Departmental Representative shop drawings, product data (including cut sheets and catalog information). Submit shop drawings, product data, and samples with such promptness and in such sequence as to cause no delay in the work or in the activities of separate contractors. The Departmental Representative will indicate approval of shop drawings, and product data.
- .2 Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
- .3 Shop Drawings: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .4 Certificates: Product certificates signed by firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.
- .5 Installation Instructions: Submit manufacturer's printed installation instructions.

1.3 Quality Assurance

- .1 Products/Systems: Provide firestopping systems that comply with the following requirements.
 - .1 Firestopping products bear the classification marking of qualified testing and inspection agency.
 - .2 Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to Departmental Representative.
- .2 Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.4 Project Conditions

- .1 Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- .2 Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- .4 Do not use materials that contain flammable solvents.
- .5 Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- .7 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

PART 2 PRODUCTS

2.1 Fire Stop Sealants And Puttys

- .1 General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.
- .2 Firestop Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.
- .3 Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.
- .4 Acceptable Manufacturers: Specified Technologies and 3M

2.2 Wall Penetration Fire Stopping Devices

- .1 Re-enterable Thru Wall fitting for fire walls and floors
 - .1 The fire stop device for use in through-penetration fire stop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark.
 - .2 The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of six cfm.
 - .3 The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces or installation recessed in acoustical ceiling.
 - .4 The fire stop device box shall be constructed of 16 gage G90 steel
 - .5 The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375° F and an unrestrained expansion between 6 to 12 times.

- .6 The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
- .7 The firestop device shall have doors which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full.
- .8 The doors shall be constructed of 16 gage G90 steel with No. 10-32 screws use to adjust opening size.
- .9 The firestop device shall be provided for 103mm trade size EMT conduit
- .10 The firestop device shall be available in safety yellow powder coat
- .11 Size 109 mm High X 145mm Wide.
- .12 Acceptable Products Wiremold FS4R-RED, Specified Technologies, or 3M.

PART 3 EXECUTION

3.1 Fire Stopping Device Installation

- .1 Install all systems as per the CEC and manufacturers recommended installation procedures.
- .2 Provide all grounding from cable tray and connections to TMGB. Connect Raceway bonding conductor separately fire stopped through room with sleeve and attach to cable tray as per section 27 05 26
- .3 Label all fire stop penetrations with provided labels indicated date installed and contractor information.
- .4 Prior to and during installation, refer to the system layout or approval drawings containing all elements of the system. Installer shall comply with complete system instruction sheets.
- .5 The fire stop device shall be installed in accordance with the UL Fire Resistance Directory, as well as any applicable codes and standards for general building, electrical and fire stopping installation practices
- .6 Provide a minimum of four Fire stop devices at wall penetration of each cable tray that originates each telecom room. Provide a minimum of two Fire stop devices at each wall that the cable tray penetrates, regardless of fire rating of wall. Additional Fire stop devices shall be provided to ensure a maximum of 40% cable fill through walls a maximum of 68 Category 6 Cables per penetration is authorized.
- .7 All penetrations shall be installed rigidly in wall opening with no air-gaps in penetration, the penetrations shall be installed to ensure maximum use of the cable tray and to ensure the cabling bend radius is not exceeded when installed.
- .8 Electronic and printed Digital pictures of each penetration clearly showing completed labeling and annotated with the As-built drawings and a chart with all UL and assembly information/ MSDS sheets shall be submitted to the Departmental Representative for approval.

END OF SECTION

PART 1 GENERAL

1.1 References

- .1 Not Used

PART 2 PRODUCTS

2.1 System Description

- .1 Electronic Safety and Security Labeling consists of the unique identifiers attached to all Electronic Safety and Security systems.

2.2 Pathway Systems Labels

- .1 CABLE TRAY LABELS
 - .1 Shall be Machine printed labels 50mm high x 75mm long
 - .2 White Colour, Adhesive backed, Polyester type
- .2 CONDUIT LABELS
 - .1 Shall be Machine printed labels 25mm high x 50mm long
 - .2 White Colour, Adhesive backed, Polyester type
- .3 GROUND SAFETY LABELS
 - .1 Shall be pre-manufactured labels 50mm high x 75mm long
 - .2 Yellow Colour, Green writing, non-adhesive backed, Rigid Plastic Tag
 - .3 Printed with the following text in BOLD “ IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CONTACT THE BUILDING Electronic Safety and Security MANAGER”
- .4 GROUNDING BUSBAR LABELS
 - .1 Shall be Machine printed labels 50mm high x 75mm long
 - .2 White Colour, Adhesive backed, Polyester type
- .5 GROUNDING CABLE RISER LABELS
 - .1 Shall be Machine printable labels 12.7mm high x 50mm long
 - .2 white Colour, non-adhesive backed, polyester polycarbonate data plate
- .6 COPPER RISER LABELS
 - .1 Shall be Machine printable labels 12.7mm high x 50mm long
 - .2 white Colour, non-adhesive backed, polyester polycarbonate data plate
- .7 OPTICAL FIBRE RISER LABELS
 - .1 Shall be Machine printable labels 12.7mm high x 50mm long
 - .2 white Colour, non-adhesive backed, polyester polycarbonate data plate

- .8 HORIZONTAL CABLE LABELS
 - .1 Shall be Machine printed labels 19mm high x 12.7mm long 6.35mm print area
 - .2 White Colour, Adhesive backed, Polyester type wraparound text.
- .9 OUTLET IDENTIFICATION LABELS
 - .1 Shall be Machine printed labels 73mm high x 75mm long.
 - .2 White Colour, Adhesive backed, Polyolefin type Laser Printed.
- .10 CABINET IDENTIFICATION LABELS
 - .1 Lamacoid 50mm high x 100mm long
 - .2 BLACK in Colour, with white Text 25mm high.
- .11 SYSTEM IDENTIFICATION LABELS
 - .1 Primary system colour label 50mm Vinyl Tape
 - .2 Secondary system colour label 12.7mm Vinyl Tape
- .12 UNDERGROUND DUCT LABELS AT MAINTENANCE HOLES
 - .1 Lamacoid 50mm high x 100mm long
 - .2 Orange in Colour, with Black Text

PART 3 EXECUTION

3.1 Installation

- .1 Install all labels to ensure Machine printing does not rub off under normal wear
- .2 Label conduit/cable tray system for the following systems:
 - .1 Voice/Data Systems.
 - .2 Backbone and Horizontal Cabling for Security Systems
 - .3 Sound Masking System
 - .4 Intercom System
 - .5 Access Control System
 - .6 Video Surveillance System
- .3 Primary/Secondary Colour for Communications Systems:
 - .1 Access Control System: Green/Brown
 - .2 Video Surveillance System: Green/Black
 - .3 Intercom System: Green/Grey
- .4 Label all conduits at point where visibly where conduit enters wall, at all pull boxes and couplings for each system in the colours indicated.
- .5 Label all Cable tray at 50mm from each connection and transition in the colours indicated for each system

3.2 Conduit Labeling

- .1 Label conduits where they penetrate the wall to the telecom outlet. The label shall indicate the pull box or cable tray and the outlet IE: TRXXX 2E01 – PBTRXXX-01 or TRXXX 2E01 – CTTRXXX-XX.

3.3 Pull Box Labeling

- .1 Label All Pull Boxes on the visible exterior with the PB number IE: PBTRXXX-XX.

3.4 Cable Tray Labeling

- .1 Label Cable Trays at each connection and transition with the cable tray label IE: CT-TR-XXX-XX

3.5 Sbb/Pbb Labeling

- .1 Label PBB/SBB IE: PBB TR-XXX.

3.6 Bonding Conductors For Telecommunications

- .1 Label Bonding conductors at each connection to Equipment, Cable tray and the PBB/SBB. IE: PBB-TEF-XXX – SBB-TR-XXX.

3.7 Copper Backbone Labeling

- .1 Label Copper Backbone Cables at point where cable enters the Telecom Room or Telecommunications Entrance Facility. IE: CR TEF-XXX 1-XXX – CR TR-XXX 1A-XX – 1XXX.

3.8 Multi Mode Fibre Backbone Labeling

- .1 Label Multi Mode Backbone Cables at point where cable enters the Telecom Room or Telecommunications Entrance Facility. IE: FMR - TEF-XXX 1-XXX – FMR - TR-XXX 1A-XX – 1XXX.

3.9 Single Mode Fibre Backbone Labeling

- .1 Label Single Mode Backbone Cables at point where cable enters the Telecom Room or Telecommunications Entrance Facility. IE: FSR - TEF-XXX 1-XXX – FSR - TR-XXX 1A-XX – 1XXX.

3.10 Cabinet Labeling

- .1 Label Cabinet in Each space. IE: CCTV-XXX C1, C2, C3 or ACCESS CTRL-XXX-C1,C2,C3, or INT ALARM XXX C1,C2,C3, etc.

3.11 Patch Panel Labeling

- .1 Label patch panels Each Cabinet. IE: A, B, C, D etc.

3.12 Patch Panel Port Labeling

- .1 Label all ports in patch panel for each Cabinet IE:. 1-X.

3.13 Patch Panel Port Labeling

- .1 Label all ports in patch panel for each Electronic Safety and Security Cabinet. 1-X.

3.14 Horizontal Cabling Labeling

- .1 Label all horizontal cables 25mm from each end with the patch panel and cabinet designation each Electronic Safety and Security Cabinet. IE: ACCESS CONTROL-XXX 2E01.

3.15 Electronic Safety And Security Outlet Faceplate Labeling

- .1 Label all faceplates with Electronic Safety and Security Designator and label each port with Rack/Patch panel Designator patch panel. IE: ACCESS CONTROL -XXX, Ports 2E01, 2E02, 2E03, 2E04.

3.16 Ground Safety Labeling

- .1 Label all Bonding conductor connections to either the TGB or TMGB with Bonding conductor safety label.

3.17 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 Waste Management: separate waste materials for reuse, recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.18 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by pathways for communications systems installation.

END OF SECTION

PART 1 GENERAL

1.1 Abbreviations And Acronyms

- .1 Electronic Access Control (EAC): control of people through entrances and exits of controlled area. Security utilizing hardware systems and specialized procedures to control and monitor movements within a controlled area.
- .2 CPVX: Central Station Burglar Alarm Systems.
- .3 CVSG: Mercantile Burglar Alarm Systems.
- .4 CVWX: Proprietary Burglar Alarm Systems.
- .5 DRS:. Door Release System.
- .6 PIN: Personal Identification Number.

1.2 Reference Standards

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S301-09, Standard for Signal Receiving Centre Burglar Alarm System and Operations
 - .2 CAN/ULC-S302-14, Standard the Installation, Inspection and Testing of Intrusion Alarm Systems.
 - .3 CAN/ULC-S304:2016, Standard for Control Units, Accessories and Receiving Equipment for Intrusion Alarm Systems
 - .4 ULC-S318:1996-R2016, Standard for Power Supplies for Burglar Alarm Systems.
 - .5 ULC/ORD-C634:2016 Connectors and Switches for use with Burglar Alarm Systems.
- .3 Underwriters' Laboratories (UL)
 - .1 UL 294-2015, Access Control System Units.
 - .2 UL 603-2013, Power Supplies for Use with Burglar Alarm Systems.
 - .3 UL 681-2014, Installation and Classification of Burglar and Holdup Alarm Systems.
 - .4 UL 827-2016, Central-Station Alarm Services.
 - .5 UL 1023-2017, Household Burglar Alarm System Units.
 - .6 UL 1076-2015, Safety for Proprietary Burglar Alarm Units and Systems.
 - .7 UL 1641-2015, Safety for Installation and Classification of Residential Burglar Alarm Systems.

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 access controls and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
- .3 Submit:
 - .1 Functional description of equipment.
 - .2 Technical data for all devices.
 - .3 Device location plans and cable lists.
 - .4 Devices mounting location detail drawings.
 - .5 Typical devices connection detail drawings.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.
 - .2 Shop drawings to indicate project layout, including details.
 - .1 Shop drawings to indicate, mounting heights and locations, wiring diagrams.
 - .2 Submit zone layout drawing indicating number and location of zones and areas covered.
 - .3 Submit wiring diagrams.
 - .4 Submit complete equipment list.
- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Submit 1 sample of each component proposed for inclusion into system. Components will be returned for incorporation into work.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .1 Submit ULC/UL Product Safety Certificates.
 - .2 Submit verification Certificate that service company is ULC/UL List alarm service company.
 - .3 Submit verification Certificate that monitoring facility is ULC/UL "Listed central station".
 - .4 Submit verification Certificate that security access system is "Certified alarm system".
- .6 Test and Evaluation Reports:
 - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .7 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .8 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.
- .9 Sustainable Design Submittals:

- .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan and Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75 % of construction wastes were recycled or salvaged.
- .2 Regional Materials: submit evidence that project incorporates required percentage 10 % of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

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 access controls and equipment for incorporation into manual.
 - .1 Include:
 - .1 System configuration and equipment physical layout.
 - .2 Functional description of equipment.
 - .3 Instructions of operation of equipment.
 - .4 Illustrations and diagrams to supplement procedures.
 - .5 Operation instructions provided by manufacturer.
 - .6 Cleaning instructions.

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, off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect access controls and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials, padding, pallets, crates, as specified in Waste Reduction Workplan and Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

1.6 Warranty

- .1 For access control materials the 12 month warranty period prescribed in subsection GC 32.1 of General Conditions is extended to 60 months.
- .2 Project Warranty: refer to CCDC for project warranty provisions.
- .3 Extended warranty period must include warranty against all defects meeting specified performance requirements, for specified time period.

- .4 Manufacturer's Warranty: submit, for Departmental Representative's acceptance, manufacturer's standard warranty document executed by authorized company official.

PART 2 PRODUCTS

2.1 Access Control And Intrusion Alarm

- .1 All access control and Intrusion alarm equipment and devices to be supplied by Departmental Representative.
- .2 Contractor to provide wiring, pathways, pull box, device box, install equipment and devices stated in item 1 above, programming and testing.

PART 3 EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for access control system 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: Burglar Alarm System

- .1 Install burglar alarm system units and components in accordance with CAN/ULC-S310, UL 1641.
- .2 Provide tamperproof unobtrusive dual gang receptacle back box with stainless steel cover plate where door release items installed in areas with suspended ceiling, fixed tile, plaster, or concrete walls, and/or metal door frames.
- .3 Fully enclose external cables in conduit or flexible protective armor, from activating unit location's enclosure receptacle back box to and above ceiling wall mounted junction boxes.
- .4 Provide tamperproof attachments for each activation unit cover plate to receptacle back box.
- .5 Enclose in conduit or flexible protective armor external cables for associated junction box to remaining system locations, from junction box to above ceiling mounted cable conduit routes.
- .6 Securely fasten all components to wall, ceiling, or other substrate or structure.

3.3 Installation: Security Access

- .1 Install security access systems and components in accordance with CAN/ULC-S310 UL 1641, UL 681, CAN/ULC-S302.
- .2 Install components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.

- .3 Install components secure to walls, ceilings or other substrates.
- .4 Install required boxes in inconspicuous accessible locations.
- .5 Conceal conduit and wiring.

3.4 Site Test And Inspection

- .1 Perform verification inspections and test in presence of Departmental Representative.
 - .1 Provide all necessary tools, ladders and equipment.
 - .2 Ensure appropriate subcontractors and manufacturer's representatives and security specialists are present for verification.
- .2 Pretesting procedure:
 - .1 Verify (utilizing an approved spectrum analyzer and test equipment) that system is fully operational and meets all system performance requirements of this specification.
 - .2 Measure and record, control (and/or voice) carrier levels of every system channel at each of following points in the system:
 - .1 Door located actuating devices.
 - .2 Door control panel functions.
 - .3 Electronic supervisory control units inputs and outputs.
 - .4 Distribution system input and output.
 - .5 Telephone system interface input and output.
 - .3 Submit to Departmental Representative copies of recorded system pretest measurements, along with pretest certification.
- .3 Performance testing:
 - .1 Test procedure: perform test on a "go-no-go" basis.
 - .1 Make only operator adjustments required to show proof of performance.
 - .2 Test to demonstrate and verify that installed system complies with installation and technical requirements of this specification under operating conditions.
 - .3 Test results to be evaluated by Departmental Representative as either acceptable or unacceptable using following procedures.
 - .2 Documentation review:
 - .1 This review will determine if information provided is sufficient to meet requirements of this specification.
 - .2 Provide for review all System manuals, as installed drawings, pretest forms, antenna radiation pattern, equipment cabinet pictorial, antenna pictorial, antenna mount pictorial, video and audio equipment details.
 - .3 Mechanical inspection:
 - .1 Departmental Representative and Contractor to tour areas to insure that Systems and Subsystems are installed in place for proof of performance testing.
 - .2 Take system inventory at this time. Verify following items before beginning proof of performance test :
 - .1 Electrical power circuits designated for system equipment are properly labelled, wired, phased, protected and grounded.

- .2 Conductor ends are protected by heat shrink wrap; audio spade lugs, barrier strips and punch blocks are used.
 - .3 Dust, debris, solder splatter, etc. are cleaned and removed from site.
 - .4 Equipment is properly labelled.
 - .5 Equipment identified in system's equipment list are in-place and properly installed.
 - .6 Each lightning and System ground method are installed in accordance with manufacturer's instructions and this specification.
- .4 Subsystem functional test:
 - .1 Conduct operational testing after review of documentation and mechanical inspection completed. Proceed as follows.
 - .1 Perform operational test of each Subsystem to verify that all equipment is properly connected, interfaced and is functionally operational to meet requirements of this specification.
 - .2 Control units:
 - .1 Take S/N readings from control unit's input and output in manual (and/or automatic) mode. Check output of DC/Data converter for S/N. Evaluate entire signal quality at baseband connector output of control unit and remote equipment.
 - .3 Audio:
 - .1 Take S/N readings from transmitter input and receiver output with equipment placed in manual gain mode. Check output of the audio converter, modulator or demodulator for S/N. Evaluate entire audio signal at baseband connector input and output of control unit.
 - .4 Distribution (or interface) system:
 - .1 Check each door utilizing a volt/ohm (or signal level) metre to confirm each function and to insure that system meets all performance requirements.
 - .2 Test each interconnection point (i.e.: door unit, junction box "cross connection", control unit, etc.) to ensure compliance with this specification.
 - .5 Total system test:
 - .1 Proceed with testing when system and subsystems are functionally tested and accepted. Total system tests to verify that requirements have been met for DC (and/or audio), sub carrier, and control signals in accordance with this specification.
 - .6 Safety:
 - .1 Demonstrate with documentation that access control system meets safety requirements specified in UL 294.
- .5 Visual verification: objective is to assess quality of installation and assembly and overall appearance to ensure compliance with Contract Documents. Visual inspection to include:
 - .1 Sturdiness of equipment fastening.
 - .2 Non-existence of installation related damages.
 - .3 Compliance of device locations with reviewed shop drawings.
 - .4 Compatibility of equipment installation with physical environment.

- .5 Inclusion of all accessories.
- .6 Device and cabling identification.
- .7 Application and location of ULC approval decals.
- .6 Technical verification: purpose to ensure that all systems and devices are properly installed and free of defects and damage. Technical verification includes:
 - .1 Validate sensitivity of readers and applicability and application of cards.
 - .2 Connecting joints and equipment fastening.
 - .3 Compliance with manufacturer's specification, product literature and installation instructions.
- .7 Operational verification: purpose to ensure that devices and systems' performance meet or exceed established functional requirements. Operational verification includes:
 - .1 Operation of each device individually and within its environment.
 - .2 Operation of each device in relation with programmable schedule and or/specific functions.

3.5 Field Quality Control

- .1 Manufacturer Services:
 - .1 Manufacturer of products, supplied under this Section, to review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services:
 - .1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
 - .2 Submit 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 Ensure manufacturer's representative is present before and during testing and critical periods of installation.
 - .4 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 Twice during progress of Work at 60% and 90% complete.
 - .3 Upon completion of Work, after cleaning is carried out.

3.6 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove protective coverings from accessories and components.
 - .2 Clean housings and system components, free from marks, packing tape, and finger prints, in accordance with manufacturer's written cleaning recommendations.

- .3 Clean components free from dirt and fingerprints.
- .3 Waste Management: separate waste materials for recycling and reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by access controls and equipment installation.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 National Research Council Canada (NRC)
 - .1 National Building Code of Canada (NBC).
- .2 Treasury Board of Canada Secretariat (TBS), Occupational Safety and Health (OSH)
 - .1 Fire Protection Standard-10.
- .3 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524-14, Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S526-07, Visible Signal Devices for Fire Alarm Systems, Including Accessories.
 - .3 CAN/ULC-S527-99, Standard for Control Units for Fire Alarm Systems.
 - .4 CAN/ULC-S528-05, Manual Stations for Fire Alarm Systems, Including Accessories.
 - .5 CAN/ULC-S529-09, Smoke Detectors for Fire Alarm Systems.
 - .6 CAN/ULC-S530-91 (R1999), Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S531-02, Standard for Smoke Alarms.
 - .8 CAN/ULC-S537-04, Standard for the Verification of Fire Alarm Systems.

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 multiplex fire alarm system 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 the Province of Manitoba, Canada.
 - .2 Indicate on shop drawings:
 - .1 Detail assembly and internal wiring diagrams for control unit, Auxiliary cabinets, Consoles, etc.
 - .2 Overall system riser wiring diagram identifying control equipment, signaling circuits, initiating zones; identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.

- .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
- .5 Step-by-step operating sequence, cross referenced to logic flow diagram.

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 fire alarm system for incorporation into manual.
- .3 Include:
 - .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
 - .4 List of recommended spare parts for system.

1.5 Maintenance Material Submittals

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.6 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.

PART 2 PRODUCTS

2.1 Description (Existing System)

- .1 Existing Fire Alarm System Edwards EST-3X
- .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating two-stage alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- .3 Zoned, two stage.
- .4 Operation of system shall not require personnel with special computer skills.
- .5 System to include:
 - .1 Initiating/input circuits.
 - .2 Output circuits.
 - .3 Auxiliary circuits and
 - .4 Devices and components as per drawings
 - .5 Wiring.
 - .6 Manual and automatic initiating devices.

- .7 Visual signalling devices.
- .8 End-of-line resistors.
- .9 Remote annunciator.
- .6 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .7 Power supply: to CAN/ULC-S524.
- .8 Audible signal devices: to CAN/ULC-S524.
- .9 Visual signal devices: to CAN/ULC-S526.
- .10 Control unit: to CAN/ULC-S527.
- .11 Manual pull stations: to CAN/ULC-S528.
- .12 Thermal detectors: to CAN/ULC-S530.
- .13 Smoke detectors: to CAN/ULC-S529.
- .14 Smoke alarms: to CAN/ULC-S531.
- .15 Regulatory Requirements:
 - .1 Fire Protection Standard.
 - .2 Subject to Fire Commissioner of Canada (FC) approval.
 - .3 Subject to FC inspection for final acceptance.
 - .4 To Canadian Forces Fire Marshal approval.
 - .5 System components: listed by ULC and comply with applicable provisions of NBC Provincial Building Code Local, and meet requirements of local authority having jurisdiction.

2.2 System Operation: Two Stage - (Existing)

- .1 Actuation of any alarm initiating device on first stage to:
 - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
 - .2 Indicate zone of alarm at central control unit and at remote annunciator display.
 - .3 For low rise buildings:
 - .1 Cause audible devices throughout building to sound at 20 strokes per minute.
 - .2 Cause audible devices in zone of alarm to sound continuously while other audible devices throughout building sound at 20 strokes per minute.
 - .4 Transmit signal to fire department via master fire central station.
 - .5 Cause air conditioning and ventilation fans to shut down or to function to provide required control of smoke movement.
 - .6 Cause fire doors and smoke control doors, if normally held open, to close automatically.
Cause elevators to return to floor of egress, or to alternate floor, as required.
- .2 Actuation of any alarm initiating device on second stage to:
 - .1 Cause audible signalling devices to sound in alarm tone throughout building.
- .3 If first stage alarm is not acknowledged within 5 minutes, ensure system automatically goes into second stage.

- .4 Acknowledging alarm: indicated at central control unit.
- .5 Ensure that it is possible to silence signals by "alarm silence" switch at central control unit, after 60 seconds period of operation.
- .6 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- .7 Actuation of any supervisory device to:
 - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
 - .2 Indicate respective supervisory zone at central control unit remote annunciator.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
- .8 Resetting alarm and supervisory device not to return system indications/functions back to normal until control unit is reset.
- .9 Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
- .10 Troubles on system: suppressed during course of alarm.
- .11 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 Control Panel (Existing)

2.4 Power Supplies (Existing)

2.5 Initiating/Input Circuits

- .1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLA configuration to central control unit.
- .2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.
- .3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".
- .4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA configuration to central control unit.
- .5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

2.6 Alarm Output Circuits

- .1 Alarm output circuit: connected to signals, wired in class A configuration to central control unit.
 - .1 Signal circuits' operation to follow system programming; capable of sounding at 20 spm bells.

- .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.7 Auxiliary Circuits

- .1 Auxiliary contacts for control functions.
- .2 Actual status indication (positive feedback) from controlled device.
- .3 Alarm supervisory and trouble on system to cause operation of programmed auxiliary output circuits.
- .4 2 sets of separate contacts for elevator capture to main floor of egress and to alternate floor of egress.
- .5 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.
- .6 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system.
 - .1 Timing circuit: controlled by CCU.
- .7 Auxiliary circuits: rated at 2 A, 24 Vdc or 120 Vac, fuse-protected.

2.8 Wiring

- .1 Twisted copper conductors: rated 600V.
- .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

2.9 Manual Alarm Stations

- .1 Manual alarm stations: pull lever, wall mounted semi-flush or surface type, and general alarm key switch for two stage system bilingual English French signage.

2.10 Automatic Alarm Initiating Devices

- .1 Heat detectors, fixed temperature, non- restorable, rated 57 degrees C.
- .2 Thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 degrees C, rate of rise 8.3 degrees C per minute.
- .3 Smoke detector: ionization type air duct type with sampling tubes with protective housing.
- .4 Twistlock Plug-in type with fixed base.
- .5 Wire-in base assembly with integral red alarm LED, and terminals for remote relay alarm LED.
- .6 Addressable smoke detector.
- .7 Ionization type.
- .8 Electronics to communicate detector's status to addressable module/transponder.

- .9 Detector address to be set on detector base head in field.

2.11 Audible Signal Devices

- .1 Bells: surface mounted, single stroke, polarized, 24 V dc, 150 mm, 98db.
- .2 Bells: to match existing type, gongs of special alloy steel, 24 V dc, 150mm, 98db.

2.12 Visual Alarm Signal Devices

- .1 Strobe type: rotating, red, 24 V dc.
- .2 Designed for surface mounting on as indicated, ceiling and walls.

2.13 End-Of-Line Devices

- .1 End-of-line devices to control supervisory current in alarm circuits signalling circuits, sized to ensure correct supervisory current for each circuit. Open , short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.14 Remote Annunciators

- .1 Remote alphanumeric LED type, with designation cards to indicate zones.
- .2 Display:
 - .1 Alarms and troubles for alarm initiating circuits.
 - .2 Supervisory alarms and troubles for supervisory initiating circuits.
 - .3 Common system trouble.
- .3 Supervised, with LED test button trouble and alarm acknowledge button.
- .4 Minimum wiring configuration with main panel and other remote annunciators.

2.15 Graphic Display

- .1 Active type.

2.16 Remote Terminal

- .1 CRT screen: 120 V, 60 Hz, to incorporate 100% solid state circuitry, with 30 cm screen and front mounted controls for brightness, contrast, vertical and horizontal hold and power ON/OFF switch.

2.17 As-Built Riser Diagram

- .1 Fire alarm system riser diagram: on black lamacoid sheet with bevelled edges, white lettering and designations in glazed frame minimum size 600 x 600 mm.

2.18 Ancillary Devices

- .1 Remote relay unit to initiate fan shutdown.

PART 3 EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for fire alarm 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 systems in accordance with CAN/ULC-S524 and Fire Protection Standard.
- .2 Install manual alarm stations and connect to alarm circuit wiring.
- .3 Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .4 Connect alarm circuits to main control panel.
- .5 Install visual and signal to signalling circuits.
- .6 Connect signalling circuits to main control panel.
- .7 Install remote annunciator panels and connect to annunciator circuit wiring.
- .8 Install door releasing devices.
- .9 Install remote relay units to control fan shut down.
- .10 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .11 Room detection system.
 - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals and visual alarms.
 - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- .12 Connect fire suppression systems to control panel.
- .13 Splices are not permitted.
- .14 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .15 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .16 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

3.3 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and CAN/ULC-S537.
- .2 Fire alarm system:
 - .1 Perform testing and verification of all new and relocated devices in accordance with Section 26 05 00 - Common Work Results for Electrical and CAN/ULC-S537.
 - .2 Note: Existing devices on existing circuits and zones are generally not shown on the drawings. It is the Contractor's responsibility to determine the locations of all existing devices to verify.
- .3 Fire alarm system:
 - .1 Test such device and alarm circuit to ensure manual stations, thermal, smoke detectors, sprinkler system transmit alarm to control panel and actuate first stage alarm general alarm ancillary devices.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of systems.
 - .4 Addressable circuits system style DCLA:
 - .1 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
 - .2 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .4 Provide final PROM program re-burn for system Departmental Representative incorporating program changes made during construction.

3.4 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.5 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by fire alarm system installation.

3.6 Closeout Activities

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

END OF SECTION

PART 1 GENERAL

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26, 27 and 28. These sections supplement requirements of Division 1.

1.2 Reference Standards

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA A23.1-[04] /A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 Quality Assurance

- .1 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
- .2 Regulatory Requirements:
 - .1 Perform Work to comply with applicable Provincial/Territorial regulations.
 - .2 Co-ordinate and meet requirements of power supply authority.
 - .1 Ensure availability of power when required.
- .3 Certificates: submit certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical properties.
- .4 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance 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 Materials

- .1 Underground ducts: rigid type DB2, size as indicated.
- .2 Rigid steel galvanized conduit and fittings: size as indicated.

- .3 Conductors: copper, type as indicated on drawings, size and number of conductors as indicated.
- .4 Concrete: to CAN/CSA A23.1/A23.2.
- .5 Backfill: clean and free of debris.
- .6 Pulling Iron:
 - .1 22 mm diameter hot dipped galvanized steel bar with exposed triangular shaped opening.

PART 3 EXECUTION

3.1 Application

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

3.2 Installation

- .1 Install cables in trenches and in ducts and conduits in accordance with CEC Installation of Cables in Trenches and in Ducts.
- .2 Allow adequate conductor length for connection to supply by power supply authority.
- .3 Install metre socket and conduit.
- .4 Allow adequate conductor length for connection to service equipment.
- .5 Make grounding connections in accordance with Section 26 05 28 - Grounding - Secondary.
- .6 Install concrete encased ducts for electrical systems as indicated and in accordance with CAN/CSA A23.1.
- .7 Install pulling irons as required.
- .8 Seal ducts and conduits at building entrance location after installation of cable.

3.3 Field Quality Control

- .1 Site Tests:
 - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .2 Perform additional tests if required by authority having jurisdiction.
- .2 Submit written test results to Departmental Representative review.

3.4 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION